POWER

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Come Across

By C. P. McDONALD

COME ACROSS with the best you have in you, with a wallop backed up by a brain; never whine that the fates are "agin" you or be so darned quick to complain; but pick up the hoe and go grubbing, just winnow the gold from the dross, break away from the droning and dubbing —show the world what you've got!

Come across!

COME ACROSS with the faith of a leader, show your hangdog persistence and grit, for the practice of trying's a breeder of those things that make a man "fit;" don't quit in the race you have started or figure each failure a loss, the world is too small for half-hearted endeavor—brace up!

Come across!

COME ACROSS with the vim and the vigor that blessed you the day of your birth, make the big deeds forerunners of bigger, for the doers inherit the earth; to the quitter black clouds seem the blacker, the buried stone gathers no moss, get out of the class of the slacker—show your mettle and force!

Come across!

Coal-Storage Basin at Duquesne Lighting Plant

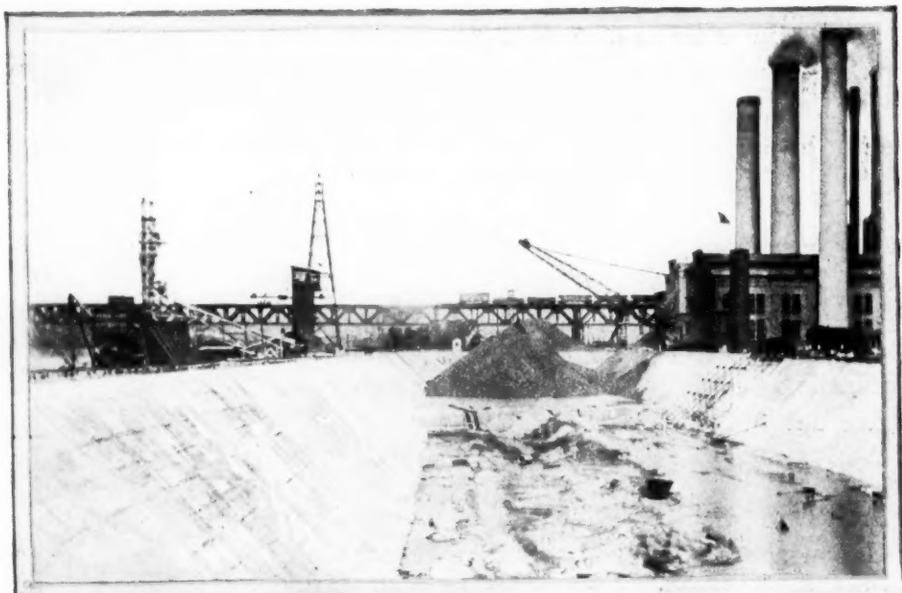
Coal is stored in a reinforced-concrete basin which has a capacity of 100,000 tons and can be submerged. Water from the river at high stages can be automatically admitted to the basin. Coal comes to the plant by rail and by water and is carried to the basin by a motor-driven side-dump car. It is taken from the basin for plant use by a locomotive crane.

POWER-PLANT operators have realized during the last three years more than ever before the necessity of storing coal. In fact the market conditions have become such that a large steam plant is not secure against a total shutdown unless a reserve supply is at hand. This serious condition of affairs was recently brought to the attention of engineers when the Interborough Rapid Transit Co., New York City, was forced to shut down its Fifty-Ninth Street Station owing to lack of coal, thus tying up the subway service for a matter of three hours. Other conditions affecting the delivery of coal are labor difficulties and the lack or congestion of transportation. With adequate storing facilities a supply of coal can be accumulated by degrees or as conditions warrant. Market conditions also offer one of the principal reasons for storing large quantities of coal. One great objection to storing certain kinds of bituminous coal in large piles is its tendency to ignite spontaneously. Furthermore, all grades of soft coal are affected to some extent by disintegration during storage and rehandling. Coals that are least liable to spontaneous combustion can be stored without special precautions, but the serious losses occasioned by storage are due to fire. Of course the atmospheric oxidation of coal when stored in a pile goes on all the time, slowly at ordinary temperatures and more rapidly at higher temperatures.

One safe method of storing coal is to put it in concrete reservoirs and keep it submerged in water. When so stored, all danger from spontaneous combustion is eliminated.

One of the first plants to adopt the submerged method of storing coal in this country was the Hawthorne[1] plant of the Western Electric Co. Analyses of the coal stored in this manner at this plant for two years, both under water and exposed to the air, showed that the coal stored under water had an advantage of 1.9 per cent. in heat value in its favor. Coal used in the Pittsburgh district is of a nature that easily becomes ignited by spontaneous combustion when stored in large piles. Because of the necessity of providing a reserve supply and the danger of its

[1]See "Power," page 238, April, 1907.



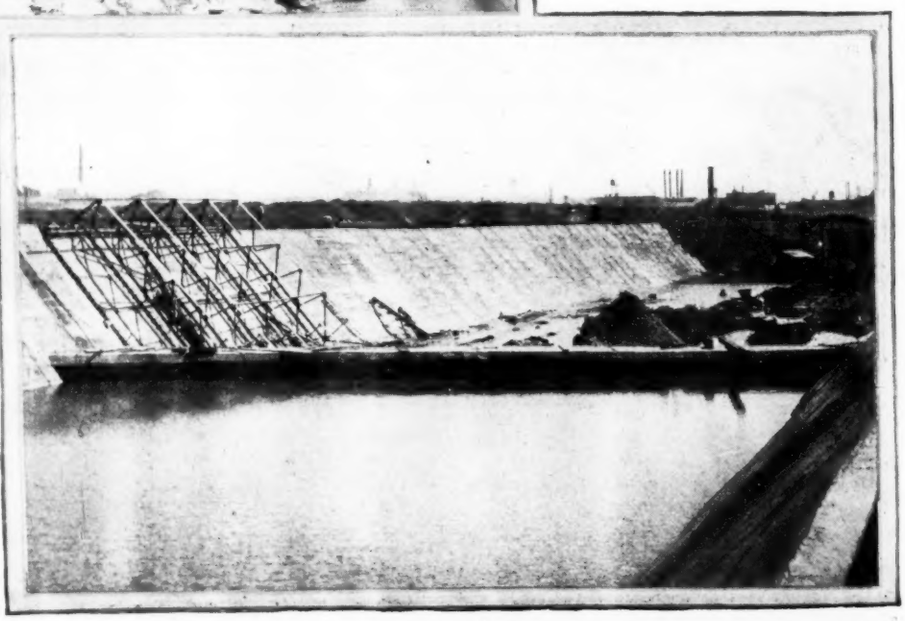


FIG. 1. TWO VIEWS OF THE REINFORCED-CONCRETE COAL-STORAGE BASIN

catching fire when so stored, the Duquesne Light Co., Pittsburgh, Penn., has just completed a large outdoor reinforced-concrete storage basin at its Brunots Island power plant.

This basin is adjacent to the power plant, and between it and the main channel of the Ohio River. It has a total length of 791 ft. and 740 ft. at the top and bottom respectively, with a width of 153 ft. and 102 ft. at the top and bottom, the side and end walls sloping at an angle of 45 deg.; the height is 25 ft. 6 in. The basin has a capacity of 100,000 tons of coal submerged, and 150,000 tons with the coal piled. Under the latter condition the probability of the coal catching fire is remote. As the bottom of the basin is below the normal river level, special precaution was necessary to take care of the lifting pressure that would be exerted on the bottom of the basin at high-water stages, the soil being of a coarse gravel and very porous. The bottom, which is 18 in. thick, is made up of 30 main reinforced-concrete slabs each 51 ft. square. These slabs rest on reinforced-concrete curbs the bases of which are 4 ft. square and 12 in. thick, the bridge extending up from the base being 15¼ in. high and 6 in. wide. These curbs, beside supporting, also allow for expansion and contraction of the concrete slabs. All joints are filled with pitch. The side and end walls of the basin taper from a thickness of 18 in. at the bottom to 8 in. at the top. Two views of the basin are shown in Fig. 1. Details of its design are shown in Fig. 3.

At about the center of the basin the plant condenser-water concrete discharge duct divides it into two sections. This duct is 7½ ft. high above the concrete bottom, which permitted one-half of the basin to be used while the other half was being constructed, Fig. 1. Water for flooding the basin is admitted through filling holes, each 12 in. diameter. Filling water is supplied by one of the plant condenser circulating pumps, which has been equipped with a discharge pipe for this purpose. Four 18-in. independent drain pipes, two for each half of the basin, extend to the river. Each is equipped with a gate and a check valve, with a bypass around the latter. The gate valve is opened by hand, and the check valve can be opened by a lever when it is desired to drain the basin. The bypass is to equalize the water pressure on both sides of the check valve, otherwise it could not be opened with the lever.

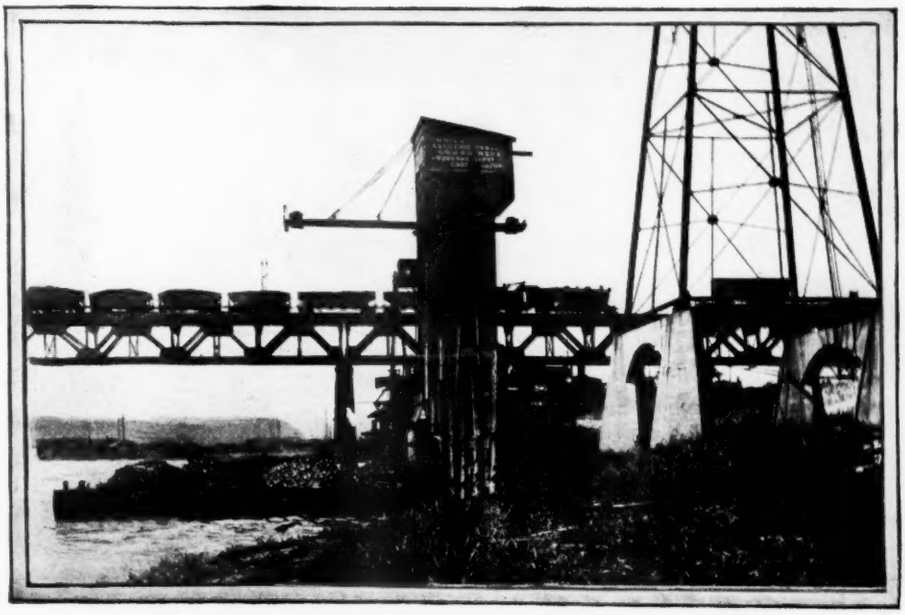


FIG. 2. COAL RECEIVED AT PLANT BY RAIL AND BY RIVER

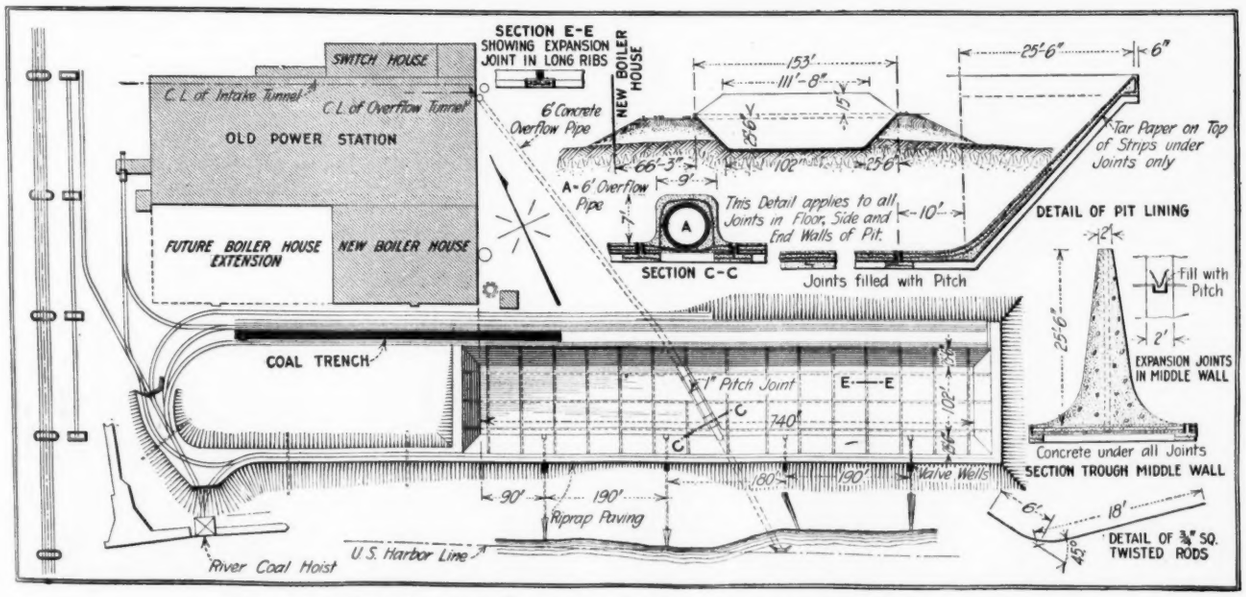

SECTION E-E
SHOWING EXPANSION JOINT IN LONG RIBS
NEW BOILER HOUSE
SWITCH HOUSE
C.L. of Intake Tunnel
C.L. of Overflow Tunnel
OLD POWER STATION
FUTURE BOILER HOUSE EXTENSION
NEW BOILER HOUSE
6' Concrete Overflow Pipe
A-6' Overflow Pipe
This Detail applies to all Joints in Floor, Side and End Walls of Pit.
SECTION C-C
Joints filled with Pitch
Tar Paper on Top of Strips under Joints only
DETAIL OF PIT LINING
Fill with Pitch
EXPANSION JOINTS IN MIDDLE WALL
Concrete under all Joints
SECTION THROUGH MIDDLE WALL
COAL TRENCH
1" Pitch Joint
Valve Wells
Riprap Paving
River Coal Hoist
U.S. Harbor Line
DETAIL OF ¾" SQ. TWISTED RODS

FIG. 3. DETAILS OF DESIGN OF REINFORCED-CONCRETE STORAGE BASIN

As the rise in the river is as much as five or six feet in twelve hours, this arrangement permits of automatically flooding the coal basin with river water, and thus relieving it of pressure from below the concrete bottom. Under such circumstances the gate valve is left open, the check valve retaining whatever water there may be in the basin. Should the river rise much above normal, water will flow into the basin to a height corresponding to that of the river.

FIG. 4. MOTOR SIDE-DUMP CAR DISCHARGING COAL INTO STORAGE BASIN

If, after the high stage of the river has subsided, it is desirable to drain the water from the basin, the gate valve which is between the check valve and the river is closed. The bypass around the check is then opened, and with the pressure on both sides of the disk equalized, the check is easily opened by means of the hand lever, thus permitting the water to drain into the river after opening the gate valve. Coal supplied to the plant, which burns during the summer months an average of 1500 tons per day, is received both by rail and by water in barges, Fig. 2. Rail coal is discharged into a drop chute, from cars on a siding on the trestle, into a crusher, from which it is carried by a conveyor to the 4500-ton coal bunkers in the boiler rooms. A side outlet of the chute permits of diverting the coal into a 15-ton motor-driven car in which it is carried to and dumped into the storage basin, when it is desirable to store the coal.

River coal is unloaded by a 4-ton grab bucket and dumped into a hopper from which it is loaded into a 15-ton capacity motor-driven side-dump car, which either delivers the coal to the crusher and plant conveyor or takes it to the basin for storage (see Fig. 4). This river bucket has a capacity of 200 tons per hour.

Coal in the storage basin is trimmed by means of a locomotive crane that operates on a track running the length of the basin. It has a capacity of 175 tons per hour and is designed to handle 200 tons per hour by using a larger grab bucket. Fig. 5 shows the crane handling the coal from the discharge point of the side-dump car, Fig. 4, to the center of the basin. When coal is to be taken from storage, the operation is reversed. The crane picks it up and discharges it into the dump car, in which it is carried to and dumped into the crusher rolls and is then conveyed to the boiler-house bunkers. All yard apparatus operates with 600-volt direct current The crane and cars operate on a third-rail system, the dump cars running on a standard-gage track, the motors being standard street-railway apparatus.

No figures are available as to the cost of operating the system as compared with others, inasmuch as up to the present the storing of coal in the basin has been intermittent. As a matter of fact, storing a sufficient supply of coal is the main consideration. One man is employed to operate the river hoisting bucket, one runs the electric car, and one the locomotive crane. As the storage of coal requires but a portion of their time, they can be employed at other duties about the plant.

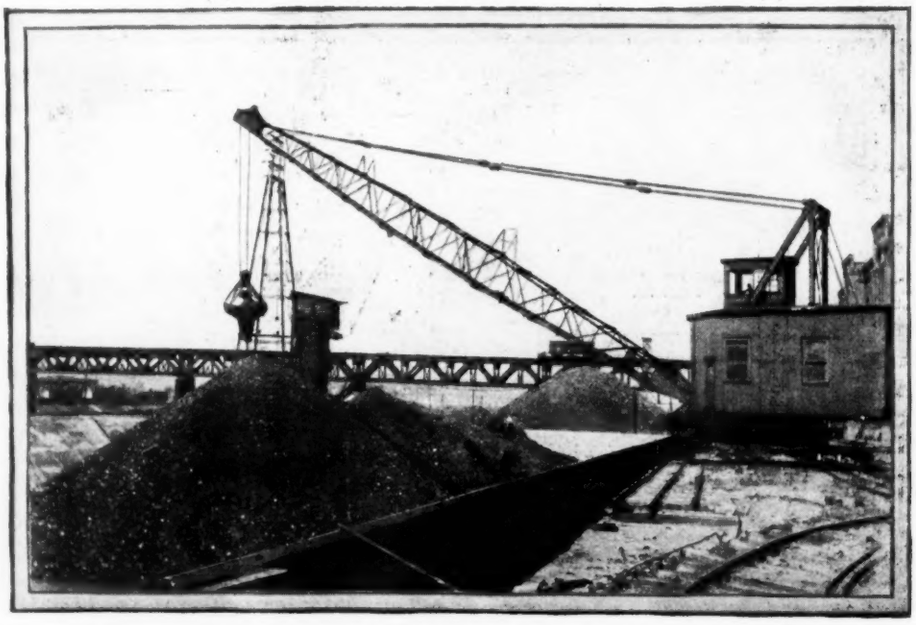


FIG. 5. MOTOR-OPERATED LOCOMOTIVE CRANE AT STORAGE BASIN

Tom Hunter, Hoisting Engineer

By WARREN O. ROGERS

Hunter tells me something about herringbone gears and their advantage over the common spur gear. The reason for the prevailing use of fire-box boilers at most of the copper mines is given and some comparisons with other types of boilers are made.

AFTER leaving the sand wheels at the Calumet & Hecla stamp mill, we went out and had a pickup lunch at a grocery store. While struggling in an endeavor to down the crackers and cheese, I kept mulling over the fact that the gearwheels on the engine-driven pump were of the spur type instead of the herringbone such as we had seen on some of the gear-driven compressors. When I put the question to Hunter, he replied:

"The idea of using the herringbone gear is to get a steady revolving effect on the gears and not a succession of hammer blows. You take a pinion meshing with a large spur gear, and that is about what is taking place, especially after the straight teeth have become worn.

"A herringbone gear with its special angle of the teeth gives a screw-like contact between the teeth. This produces a uniform push in the direction of rotation all through the revolution. A herringbone gear is really a double-helical gear, but to avoid trouble the teeth have got to be accurately cut and the alignment of the gear shaft must be right up to the dot. There isn't much use of a machinist spending a lot of time getting a true finish in cutting the teeth of such a gear if the men who erect the gears or machines on which they are mounted do not have a firm foundation on which to mount it.

FIG. 1. BOILER ROOM CONTAINING TWENTY 500-HP. WATER-TUBE BOILERS

"You know that it is necessary to install any machine level and that it should be kept level after it is running, and that applies especially to a gear-driven machine. If the gear shaft and pinion are not leveled truly and accurately spaced, then look out for trouble. A herringbone gearing should be set so that the gear and pinion mesh with approximately 0.015 in. clearance, and because of this when the bearings become badly worn they should be adjusted by putting shims back of the quarter-boxes so as to keep the gears at the original centers."

"Why don't we see more of that type of gear used?" I asked. "If there is none of that hammering, as you call it, there should be less noise than with the ordinary spur gear."

"You must remember that most of the gear drives we have seen were put in before the herringbone gear came into use. As for noise, everybody knows that the spur gear is noisy enough and then some, but the herringbone gear is not what you would call noiseless. How can you expect metal-to-metal teeth, carrying a heavy load, to be silent running? It can't be done, although the herringbone gear is a whole lot more quiet running than the spur type. This noise is greatly reduced if the gears are lubricated with a proper lubricant, which should be heavy and viscous, or sticky. A good dope for new gears when starting up is to slush them with white lead to keep them from cutting. After running for a short time, this should be removed and the regular lubricant applied." "That doesn't give me much information. What might a regular lubricant be?" "Well, I suppose if I told the truth I should say that it contains considerable paraffin wax mixed with a heavy mineral oil, in the cheap inferior grades, but to my way of thinking, paraffin is not a good lubricant. A good compound for gears can be made by blending a mineral oil with fiber grease." "There you go again. Now, what is a fiber grease?" "Getting right down to brass tacks, you are," replied Hunter. "A fiber grease is usually made by saponifying a fatty oil with sodium or potassium hydroxide and a little water; then the water is boiled out and the mineral oil is mixed in. By varying the proportions you can get different grades of hardness of the grease. Lard and cottonseed oils are good fatty oils."

By the time Hunter had finished his discourse on gearing, we had eaten the crackers and cheese and we then went to the boiler room of the stamp-mill power plant. Here we found the first really up-to-date installa-

tion that we had seen. There were 20 water-tube boilers, each of 500 hp. capacity and equipped with mechanical stokers fed from an overhead bunker, Fig. 1. We had seen much smaller boiler plants containing water-tube boilers, but most of the steam generators were of the locomotive type (Fig. 2) having twin furnaces. Some of them were of 750 hp. capacity and built up to at least 84 in. diameter; others smaller.

"What's the idea of the general adoption of the firebox type of boiler up here in the copper country?" I asked, having recovered from the exercise of catching my camera that a fireman had knocked over with a firing tool. "You've noticed that, have you?" asked Hunter. "Well, it is a fact that wherever you go you will find that what one fellow starts another adopts and it soon becomes the fashion. At the steel mills the gas-fired vertical boiler is common, usually standing out in the open with but little protection from the elements. In the New England cotton mill the upright fire-tube boiler is found predominating in many sections; at the coal mines the return-tubular boiler is 'it' and at the copper mines the firebox boiler is all the go, and there are reasons. Most types of boilers require an expensive brick setting, although that is the common method of installing them. But here in the copper country you don't see many boilers with brick settings, as you have noticed. I suppose that the firebox boiler came into use largely during developing work because they were semiportable and could be set up anywhere without bothering about bricking them in.

"You may not know it, but that type of boiler is a rapid steamer and does not cost so much to put in. When it comes to water evaporation, the old firebox boilers are not so far behind other types as you might think, and I believe that tests have shown that they will evaporate a matter of 10 lb. of water per pound of coal from and at 212 deg. F."

"That may be," I replied, "but I should think that there would be considerable heat losses. I remember riding on a locomotive a while ago and the fire could be seen coming out of the top of the smoke-stack."

"I don't doubt you for a minute," replied Hunter, "but you must remember there was a mighty strong induced draft in the stack of the locomotive, caused by the escape of the exhaust steam. With the firebox boiler there is nothing of the kind, the draft being on the natural order of things, and the flue temperature, with proper firing and the boiler clean and in proper shape will be around 430 to 550 deg., which compares well with other types of boilers. Furthermore, the steam is just about as dry as that generated by other types of boilers, unless the boiler is forced hard and greatly overloaded.

"You see, that type of boiler is easily forced and it is common practice to run them considerably above their normal rating, and some of them when forced can burn a raft of coal per square foot of grate area, but the flue temperature under such conditions would be high and the moisture in the steam would float a ship, so to speak."

"Well, how about their safety? I have noticed that locomotive-boiler explosions are common on railroads and I should suppose that the firebox type used here would be just as likely to become burned and finally replaced."

FIG. 2. A COMMON TYPE OF FIRE-TUBE BOILERS WITH DOUBLE FURNACE DOORS

"That is a natural supposition," replied Hunter, "but as a matter of fact I believe the records will show that there has never been an explosion of that design of boiler, although it has a large area of flat stay-bolted surface. and is frequently overheated. As regards safety, of course, a water-tube boiler is preferable, because in case of a rupture it is generally in one of the tubes and the damage is confined to it alone instead of blowing the boiler house to pieces, as would be the case with a return-tubular or a firebox boiler.

"I believe the first water-tube boiler in this neck of the woods was put in at the College mine about 23 years ago and that it was shortly followed by several others. Some of the men liked them and others did not, it being largely, I imagine, a matter of not being familiar with their operation and their care."

"Well, what about repair?" I asked. "There surely must be something in favor of the firebox boiler beside the absence of brickwork or they would not continue in favor."

"My opinion is that, with ordinary repairs, a water-tube boiler can be kept in such shape that it can be made to carry its normal pressure for years. On the other hand, it has been the custom with firebox boilers to reduce the steam pressure as the boiler grows old because there is an uncertainty regarding the condition of the shell. I think that when it comes to high pressure, initial cost and upkeep, it would be in favor of

the water-tube boiler, although a firebox boiler would cost, before war-time prices, somewhere around $8 to $10 per horsepower as against, say, $14 for the water-tube boiler. At that rate, although the latter boiler would cost the most, it would be cheaper in the long run, because after a few years the insurance inspector would cut the steam pressure, and then where would you be?"

"I should think that could be gotten over by making the shell of the plates of the firebox boiler thick enough to safely carry, say, 180 lb. or so and let the inspector cut the pressure as may be necessary as the boiler ages. At the end of 20 years the saving might be greater than the cost of a water-tube boiler."

"That could be done; as a matter of fact, the average boiler pressure now carried is between 150 and 160 lb. So you can see that the boilers are designed to carry fairly high pressure as they are."

We had by this time reached the power house, where we found new matters to interest us.

Hot-Water Heating Under Forced Circulation—VI*

By CHARLES D. ALLAN
Consulting Engineer for the Mechanical Equipment of Buildings, Chicago

In this installment consideration is given to hot-water boilers, expansion tanks, circulating pump, the automatic removal of air, return headers and meters.

THERE are many plants of considerable size that have no power plants of their own and buy current for power and light from public-service corporations. In these plants no exhaust steam is available for heating, and where a hot-water system is installed, the circulating water is heated by passing it directly through a boiler as in gravity work.

A boiler used in such a plant would not be subject to the high pressure maintained in a modern steam plant, and the ordinary horizontal fire-tube boiler is usually installed. While this boiler may be of standard construction in every way, considerable saving in first cost may be obtained by filling the entire shell with tubes, as no steam space is necessary. Fig. 1 and Table I give full data regarding the tube spacing, capacities, etc., of a number of sizes from 54 to 72 in. diameter of shell that work out well in practice and can be built in any regular boiler shop. Boiler inlet and outlet connections should be the same size, the inlet being located where the blowoff is usually placed and the outlet at the top of the shell near the front, so that the direction of flow of the circulating water is opposite to that of the gases of combustion. A safety valve set to blow off at about 25 lb. in excess of the combined static and friction-head pressure should be installed to guard against carelessness in operating the boiler when the circulating pump has been stopped. While this type of boiler is most commonly employed for this service, there are other standard forms of construction that will answer equally well, and if water-tube or other types are preferred, the manufacturers find no difficulty in meeting the problem they present.

One of the most important accessories of a hot-water heating system is the expansion tank, the purpose of which is to provide automatically for the change in volume of the circulating water due to changes in temperature. This tank should be of sufficient capacity to provide for expansion or contraction of the circulating medium and be provided with a relief valve to care for the overflow when expansion raises the pressure above the predetermined limit, a check valve to admit air when the water recedes by reason of contraction in volume, an automatic water feeder to admit makeup water when the water in the tank drops below a certain level, and pressure and water gages. The automatic water feeder is a float-controlled inlet valve, a standard manufactured appliance.

Fig. 2, and Table II of sizes, fully illustrate the construction, capacity and method of making expansion-tank connections. In most cases the horizontal type is used and is placed above the highest point of the system. If circumstances do not permit the tank to be placed here, the vertical or closed pneumatic type may be used and placed in the engine or boiler room, in which case a small electric or a locomotive type of air pump is used, or compressed air at sufficient pressure will serve the purpose. The admission of the compressed air is controlled by a hand valve, and the air is admitted to the tank at such intervals as may be necessary to maintain sufficient pressure in the tank to keep the circulating water up to the top of the system.

Whether the horizontal or vertical type is used, the connection to the system, marked *G* in the illustration, should always be made in the main return line and as near as possible to the inlet of the pump, where the pressure in the circulating mains is least. For example, if the expansion-tank connection were made at any point in the circuit where the unused head available for pipe friction would be sufficient to flood the tank, the circulating water would be forced out through the expansion-tank overflow and the system would fill with air. By connecting the expansion tank at the pump inlet where the pressure is least and automatically admitting makeup water through it, the system is kept solidly packed with water and all air is forced out through the automatic air valves at high points provided for that purpose.

As previously stated, the circulating pump operates in a closed circuit and delivers water against the friction head only, the static head being balanced and consequently the same on both inlet and outlet sides. As the pump is always on the ground floor, there is at all

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times pressure on the suction side due to the static head. This condition is most favorable to the use of a pump of the centrifugal type, and it is practically universal custom to install a pump of this kind. Convenience and durability suggest a horizontally split casing and bronze impeller, size and other details of construction being left to the manufacturer to suit the duty required. The details of the motor or steam-turbine construction should also be left with the manufacturers except that it should be required that the motor or turbine be directly attached to the shaft. This may mean a slower speed than that most efficient for the turbine, but live steam in excess of that necessary to drive the turbine will probably be required for heating, and the turbine therefore acts as a pressure-reducing valve. Efficiency is not the primary requisite.

A condition that must be guarded against in one of these systems is the accumulation of air at high points, and much thought and attention must be given to prevent trouble from this source. At high points in the distributing mains and at all points where a main line turns down, an automatic air trap should be installed and connected as shown in Fig. 3. This device is in principle a float steam trap upside down; that is, when the water rises in the trap the vent is closed, and when the water level recedes and is replaced with air the vent opens. It is a stock article and can be purchased on the open market from a number of manufacturers.

Fig. 4 shows the position of the air valve on a radiator. This valve is of the ordinary nickel-plated key-operated type and should be placed on every radiator. Fig. 5 shows the position of the air valve on an overhead pipe coil at the top of an air pocket. It is constructed of a pipe nipple and cap to allow some air-storage capacity.

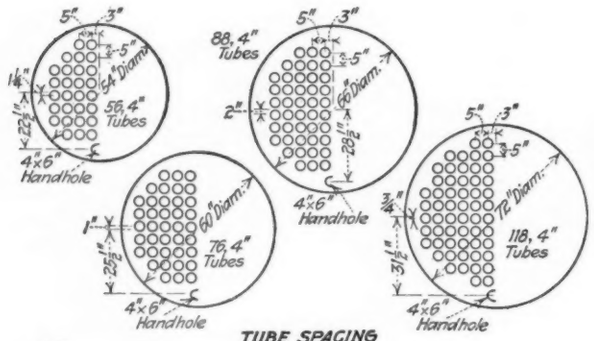
While pipe sizes may be figured with fair accuracy by the method previously explained, mechanical means for adjusting the flow in the various lines after the work is installed must be provided, as there is usually a factor of error that must be cared for. The return header into which the main return lines converge, such as is illustrated in Fig. 1 of Article V, with thermometers, permanent adjustment valves, shutoff valves and thermometers in each, is the most simple and effective appliance for this purpose. The header itself is a special fitting similar to the ordinary branch tee except that it is larger in size and for convenience in changing connections has all outlets flanged and in this form is more serviceable and less costly than if built up of separate flanged, faced and drilled tees. Each separate return line connected into the header should be provided with a thermometer, a drain valve, a shutoff valve, usually

TABLE I. HEATING SURFACE AND CAPACITY OF HEATING BOILERS

Diam. of boiler in inches	54	54	60	66	66	72	72
Length of boiler in feet	14	16	16	16	18	16	18
Diam. of tubes in inches	4	4	4	4	4	4	4
Number of tubes	56	56	76	88	88	118	118
Heating surface, sq.ft. tubes	821	938	1,273	1,474	1,658	1,977	2,224
Heating surface, sq.ft. other	143	162	180	204	227	235	262
Heating surface, sq.ft. total	964	1,100	1,453	1,678	1,885	2,212	2,486
No. of 1,000 B.t.u. per hour = sq.ft. (tube surface) × 33,305 / 10 × 1,000	2,734	3,124	4,240	4,909	5,522	6,584	7,407

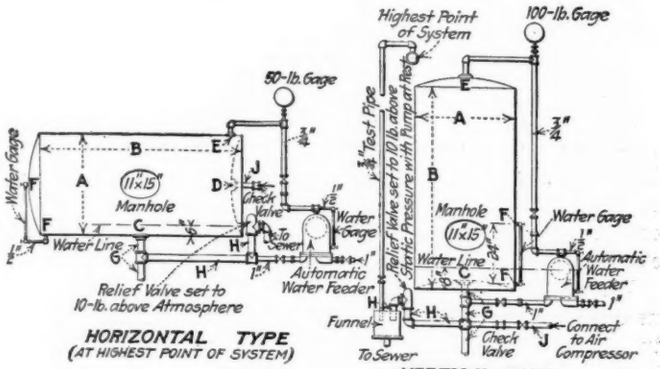
TABLE II. DIMENSIONS AND CAPACITY OF EXPANSION TANKS

Dimensions in Inches			Tapping			Pipe Sizes			Valves		Sq.Ft.
A	B	C	D	E	F	G	H	J	Check	Relief	Radiation
36	72	2	1	3/4	3/4	2	1 1/2	1	1	1 1/2	30,000
48	96	2 1/2	1 1/2	3/4	3/4	2 1/2	2	1 1/2	1 1/2	2	60,000
60	120	3	1 1/2	1	1	3	2 1/2	1 1/2	1 1/2	2 1/2	120,000



TUBE SPACING

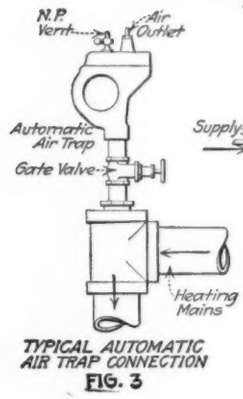
FIG. 1



HORIZONTAL TYPE (AT HIGHEST POINT OF SYSTEM)

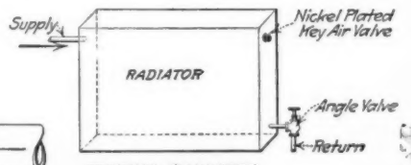
VERTICAL TYPE (AT LOW POINT IN CENTRAL STATION)

FIG. 2



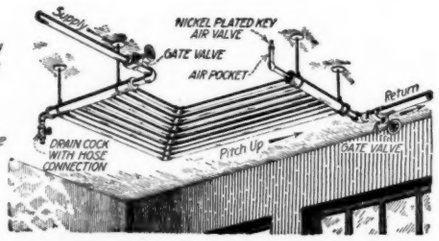
TYPICAL AUTOMATIC AIR TRAP CONNECTION

FIG. 3



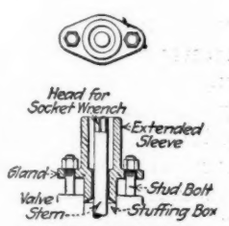
TYPICAL RADIATOR CONNECTION

FIG. 4



TYPICAL OVERHEAD COIL CONNECTION

FIG. 5



ADJUSTMENT VALVE

FIG. 6

FIGS. 1 TO 6. TYPICAL EQUIPMENT AND FITTINGS USED ON HOT-WATER HEATING JOBS

Fig. 1—Special horizontal hot-water boilers. Heating surface, etc., given in Table I. Fig. 2—Expansion tanks, horizontal and vertical. Dimensions and capacity given in Table II. Fig. 3—Typical automatic air trap. Fig. 4—Position of air valve on radiator. Fig. 5—Overhead coil connections. Fig. 6—Permanent adjustment valve

of the nonrising stem gate pattern, and a permanent adjustment valve of the same kind but with an extended sleeve on the gland, as shown in Fig. 6, so it can only be operated by a key. These permanent adjustment valves can then be set so that all thermometers read the same, in which case it naturally follows that the temperature drop will be the same in all circuits, a condition that is required for proper operation.

A shutoff valve is installed on each return branch in addition to the permanent adjustment valve, so that the line can be shut off without disturbing the latter. Any reliable thermometers may be used, and they should ordinarily be graduated to 250 deg. F. A thermometer should also be installed in the main supply line so that the temperature drop of the circulating water may be known at all times. Drain valves, usually ¾-in., should be of the gate pattern and provided with hose thread to match that adopted in the plant.

A properly designed plant should always have a return header in the central station to control the return lines from individual buildings or sections of a single large building. If the plant is very extensive, several of these headers may be located at different points for controlling the flow in such subdivisions as circumstances may necessitate.

Where this system of heating is installed, the heat used can be simply and accurately metered by a venturi tube. The first cost of this appliance is so small that the additional expenditure is fully warranted if an accurate knowledge of the cost of heating is desired. This apparatus is so well known and its reliability so well established that no special description of it is necessary. The simple indicating type without recording attachment is generally used, and it may be specially graduated to read in pounds of water per hour if so ordered. This reading, combined with the thermometer readings of main supply and return lines, gives the exact amount of heat in B.t.u. per hour that is being absorbed by the system at any time, information that greatly facilitates the intelligent operation of the plant and the planning of extensions.

In conclusion the writer desires to say that the experimental stage of this method of heating has long since passed, and the statement that it now has the preference, particularly in large manufacturing plants, is fully justified. Because of the absence of published data, an unusual condition when the extensive use of the system is considered, it is hoped that the information given in this series may be of real service.

Learn to work with your fellows. It is not enough that you should tolerate them and avoid wronging them. It is not enough that you should mind your own business and be self-supporting. Civilization has been created and is carried on by teamwork. Get into the game. Take your part in the great collective struggle to make life more worth while for everybody. Study to combine your efforts with the efforts of others in this great enterprise, tactfully, intelligently and effectively. —*Prof. Franklin H. Giddings, Columbia University.*

Why not distribute to power-plant owners the Bureau of Mines bulletins on burning soft coal, Mr. Garfield, and urge owners to see that their firemen make good use of them?

The Fuel Value of Wood

Those who plan to relieve the coal shortage this winter by burning wood can figure, roughly, that two pounds of seasoned wood have a fuel value equal to one pound of coal, according to experts of the United States Forest Service. Different kinds of wood have different fuel values, and in general the greater the dry weight of a nonresinous wood the more heat it will give out when burned. For such species as hickory, oak, beech, birch, hard maple, ash, locust, longleaf pine or cherry, which have comparatively high fuel values, one cord, weighing about 4000 lb., is required to equal one ton of coal; it takes a cord and a half (a total weight of 4500 lb.) of shortleaf pine, hemlock, red gum, Douglas fir, sycamore or soft maple, which weighs about 3000 lb. a cord, to equal a ton of coal; while of cedar, redwood, poplar, catalpa, Norway pine, cypress, basswood, spruce and white pine, two cords, weighing about 2000 pounds each, or 4000 lb., are required.

Weight for weight, however, there is very little difference between various species. Resin affords about twice as much heat as wood, so that resinous woods have a greater heat value per pound than nonresinous woods, and this increased value varies, of course, with the resin content. The available heat value of a cord of wood depends also on the amount of moisture present. When the wood is green, part of the heat that it is capable of yielding is taken up in evaporating the water. The greater the amount of water in the wood the more heat is lost. Furthermore, cords vary as to the amount of solid wood they contain, even when they are of the standard dimension and occupy 128 cu.ft. of space. A certain proportion of this space is made up of spaces between the sticks, and this space may be considerable in a cord of twisted, crooked and knotty sticks. Out of the 128 cu.ft., a fair average of solid wood is about 80 cu.ft. This, however, applies to the standard cord, in which the sticks are cut to 4-ft. lengths and piled 4 ft. high and 8 ft. long. Instead of the 4-ft. lengths, however, users often have the sticks cut into 2-ft. lengths. Care should be taken to see that full measurement is given when wood is bought in this way. In parts of New England a stack of 16-in. wood 4 ft. high and 8 ft. long is commonly sold as a "run," but contains only one-third of a cord.

Where wood is to be burned in a furnace intended for coal, it will be found desirable to cover the grate partly with iron or firebrick, in order to reduce the draft. If this is not done, the wood is wasted by being consumed too fast, and makes a very hot fire, which in a furnace may damage the firebox.

It was the elder Trautwine who said that authors often "exhibit a profundity of knowledge beyond the reach of ordinary men—yet their language is so profound that very few engineers can read them, and their works are little more than striking instances of how completely the most simple facts may be buried out of sight under heaps of mathematical rubbish."

Sweden also is rationing her electrical supply. America still clamps the circuit-breakers closed on the "white-way" lines for fear they will blow out, leaving the gun sign dark for a minute or so.

Reconnecting Induction Motors—For Changes in Phase

By A. M. DUDLEY
Designing Engineer, Westinghouse Electric and Manufacturing Co.

The factors affected in the performance of an induction motor, when the winding of a two-phase motor is reconnected to operate on a three-phase circuit and vice versa, are discussed, and different schemes of connections given that may be used to accomplish this end.

IT WAS shown in the last article, Sept. 11 issue, that changes in voltage of the supply circuit can be taken care of with comparative ease and simplicity by the proper changes in connection of the motor windings, provided that the maximum number of turns which can be placed in series in the coils is equal to or greater than the number required under the new conditions. For example, a 220-volt motor may be reconnected for 440 volts, provided the windings can be so arranged that there will be twice as many turns in series between the terminals of each phase as there were with the original connection. These changes, when possible, offer no particular difficulty.

On the other hand, changes in the number of phases of the supply circuit are usually difficult to accommodate by changes in the motor connections and many times when they can be accomplished are attended with a loss in capacity of the motor or a serious reduction in the excellence of the motor's performance as regards torque, heating, power factor and efficiency.

By far the commonest change of this nature is changing from two-phase to three-phase and vice versa. Of the two changes, that from two-phase to three-phase can more often be taken care of for the reason that a normal two-phase motor has approximately 25 per cent. more turns in series in its windings than a three-phase motor of the same characteristics. Thus it is usually possible to cut out 20 per cent. of the turns in a two-phase winding, leaving them dead, and have left the proper number of turns for the corresponding three-phase winding. However, in going from three-phase to two-phase a corresponding increase of 25 per cent. of the total number of turns in series is required; and if the three-phase winding as it stood had all the turns in series, any further increase is not possible and a set of new two-phase coils will be required.

There are three methods of reconnecting from two-phase to three-phase, which are here given in the order of their desirability: (1) Twenty per cent. of the coils are cut out and left dead and the motor operated on 80 per cent. of the two-phase turns; (2) the number of coils is not changed, and the coils are reconnected according to the proper diagram; (3) a "T" or Scott two-phase to three-phase connection is used.

None of these is ideal, and in general it is a good investment to rewind the motor with proper three-phase coils. In the first method it must be borne in mind that the full-load current of a three-phase motor is $\frac{2}{1.73}$, or about 115 per cent. of the current in a two-phase motor. This means that for the same heating the horsepower output when reconnected for three-phase can only be in the neighborhood of 87 per cent. of what it was on two-phase. This loss of 13 per cent. of the horsepower when capitalized in the proper manner will

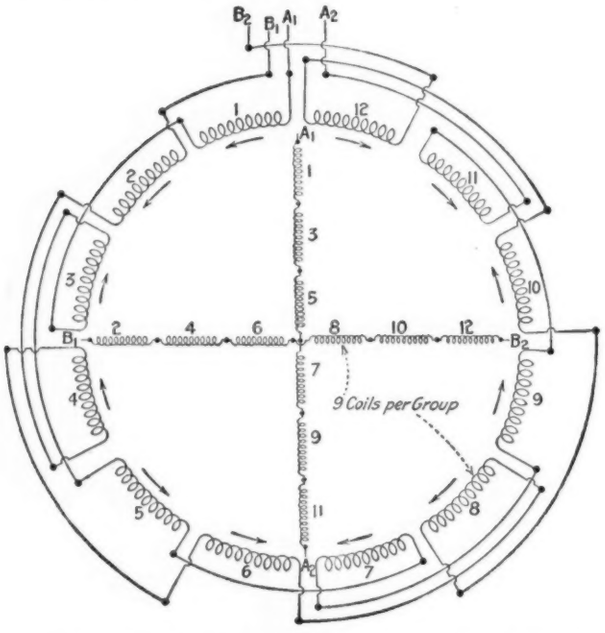


FIG. 1. TWO-PHASE, SIX-POLE, NINE COILS PER GROUP, SERIES-CONNECTED WINDING

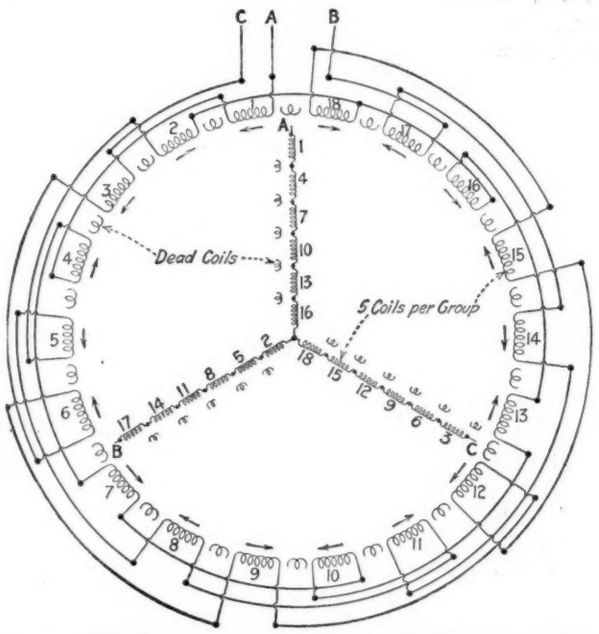


FIG. 2. WINDING IN FIG. 1 RECONNECTED FOR THREE-PHASE, SIX-POLE, SERIES-STAR

be found to pay a high rate of interest on the money that would be invested in a new set of coils for normal three-phase operation which would give the same horsepower output as the original two-phase winding.

Another way of arriving at the foregoing conclusion is as follows: If one-sixth of the two-phase coils are

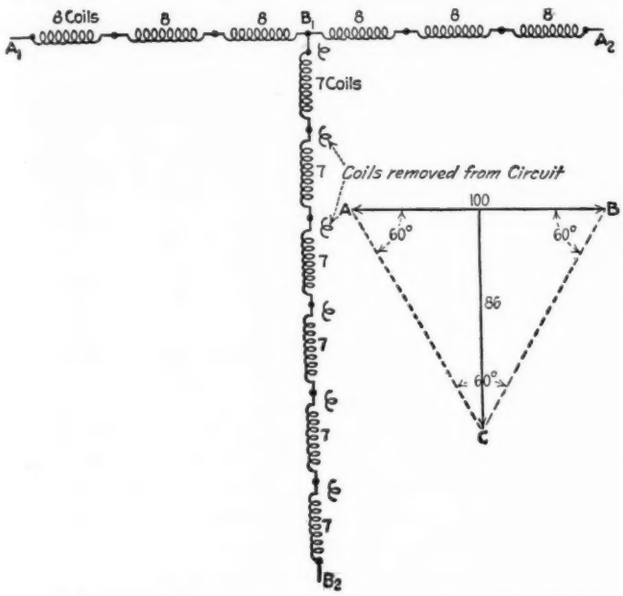


FIG. 3. SCHEMATIC DIAGRAM OF A TEE-CONNECTED INDUCTION-MOTOR WINDING

to be cut out of circuit and left dead, as shown in Fig. 2, the amount of active copper is reduced by the same percentage; and it might be expected that the horsepower output would be similarly reduced, which is the case. This method of reconnecting from two-phase to three-phase is shown in Figs. 1 and 2. Fig. 1 shows a winding with 108 coils connected in series for two-phase and six poles. There are $2 \times 6 = 12$ pole-phase groups and $\frac{108}{12} = 9$ coils in each group. As already stated, if this winding is to be reconnected for three-phase, six poles, there should be only 80 per cent. as many coils in series in the winding, or $0.80 \times 108 = 86.4$ coils.

Since there are to be $3 \times 6 = 18$ pole-phase groups in the new connection, there should be the same number of coils in each group; the nearest integer is 5, and $5 \times 18 = 90$ coils, which will be used instead of 86.4, which is theoretically correct. This leaves $108 - 90 = 18$ coils dead, or 1 dead coil in each group, as shown in Fig. 2. Since $\frac{90}{108} = 0.833$, then 83.3 per cent. of the coils are active instead of 80 per cent., and this will have the effect of operating a three-phase motor on $\frac{80}{83.3}$, or 96 per cent. of normal voltage, as compared with the two-phase motor. The starting and maximum torques of the three-phase motor will be about $\left(\frac{80}{83.3}\right)^2 = 92$ per cent. of their value on a two-phase connection; but this is sufficiently close for all practical purposes, especially as the horsepower rating will have to be reduced 13 per cent., as stated above, if the original maximum heating in the stator coils is not to be exceeded. A comparison of Figs. 1 and 2 indicates that the position of the coils, which are specially insulated to stand the voltage between phases, will have to be changed. This was mentioned in the article on phase insulation, July 31 issue.

A consideration of the fact that there are 18 dead coils in the three-phase winding which are active on the two-phase connection suggests at once that if the reconnection was attempted from three-phase to two-phase there might in many cases be insufficient coils to put in series for the two-phase connection. If the coils are regrouped for two-phase and run on the

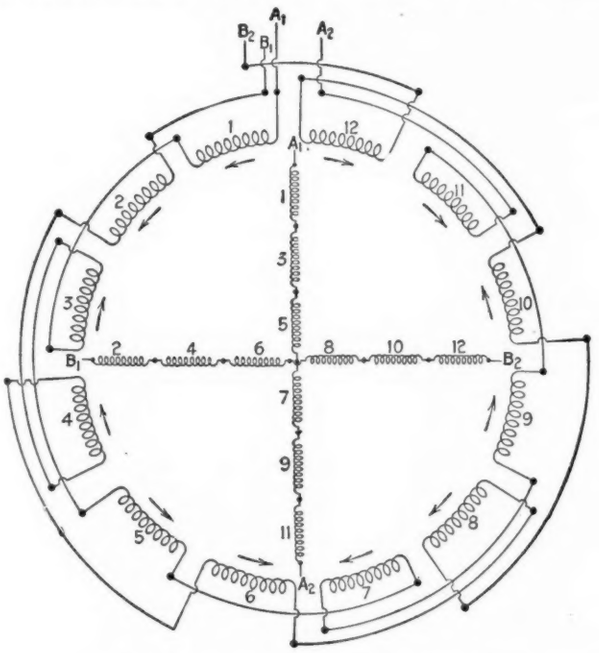


FIG. 4. TWO-PHASE, SIX-POLE, EIGHT COILS PER GROUP SERIES-CONNECTED WINDING

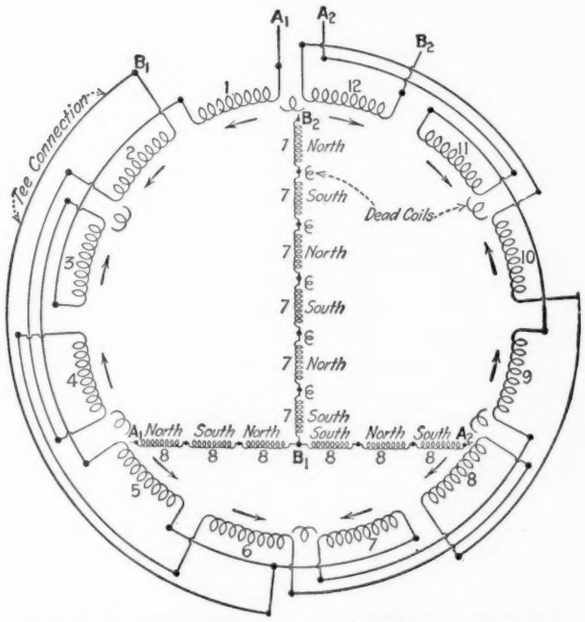


FIG. 5. WINDING IN FIG. 4 CONNECTED TEE FOR THREE-PHASE SIX-POLES

same voltage, the motor shows all the signs of a machine operating on 25 per cent. overvoltage and may even overheat when running light and not connected to any load whatever. On the other hand, if a two-phase winding is regrouped and operated three-phase on the same voltage without cutting out any coils, as explained in connection with Fig. 2, the three-phase

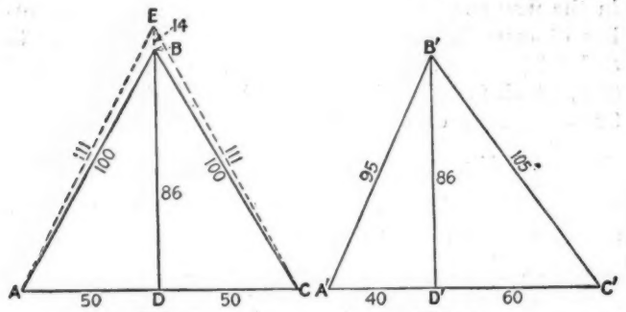


FIG. 6 FIG. 7

FIGS. 6 AND 7. VOLTAGE DIAGRAMS OF A TEE-CONNECTED WINDING

Fig. 6—Voltage diagram for "Tee" connection as shown in Figs. 3, 5 and 8. Fig. 7—Voltage diagram for "Tee" connection showing distortion that might occur due to the motor being out of center in the stator bore

motor shows all the effects of a motor operating on 80 per cent. of normal voltage; that is, the starting and maximum torques will be considerably reduced and the heating increased. These two latter conditions are covered by the second method of reconnecting listed in the foregoing—namely, changing the grouping and connections properly, but neglecting the change in the total number of coils in series.

The third method occasionally employed is that of making a "T" connection of the two-phase windings or a Scott connection inside the motor and operating the resulting winding on a three-phase circuit. This should not be confused with the use of Scott connected transformers for changing from two-phase to three-phase or vice versa. The latter may be an excellent solution in many cases where there are several motors affected by the change in phase. Let us assume, for example, that a user of motors has 15 machines of various sizes from 1 to 50 hp., which have been operating from his own steam-driven plant at two-phase, 220 volts. He decides to purchase power from a neighboring distribution system at three-phase, 220 volts. It is a matter of considerable expense to rewind all the motors for three-phase, and if simply reconnected the losses on the rated capacity are as previously suggested. In addition, it is desired to hold the old generating plant as a stand-by, in case of interruption to the purchased service. All these results can be secured by putting in transformers equivalent to 50 or 60 per cent. of the capacity of motors installed and by means of a Scott connection on the transformers operate the two-phase motors from the three-phase supply in a perfectly normal manner. This is one very neat solution for a problem in reconnecting induction motors which does not involve any reconnection whatever.

On the other hand, assume that in the same plant the generating system has broken down and, in the emergency, power can be purchased from the same neighboring power line at three-phase. There is no time to secure transformers, and there is no time to secure three-phase coils for the motors—it then becomes essential to make some kind of reconnection so that the two-phase motors will operate on three-phase. One of the possibilities in such a case is a Scott connection inside the motor winding itself. This has been referred to in the table and Fig. 12 in the fifth article, May 22 issue. For convenience, they are here reproduced in the accompanying table and Fig. 3.

The table shows comparative performances of a two-phase motor reconnected for operation on three-phase by a "T" connection and the performance of the same

COMPARISON OF A TWO-PHASE MOTOR CONNECTED "T" TO OPERATE ON THREE-PHASE

	Normal Two-Phase Winding	Three-Phase "T" Connection	Normal Three-Phase Winding
Full-load efficiency	88	86.9	88.5
Full-load power factor	89	84.8	90
Starting torque	1.75	1.20	1.94
Maximum torque	3.3	3.17	3.3
Deg. C. Rise at Full Load:			
Stator copper	22.5	32	21
Stator iron	20	32.5	19
Rotor copper	22	30	22

motor when supplied with new three-phase coils and connected in a normal three-phase manner.

In order to make this connection clear, Fig. 4 shows the windings on the motor connected for two-phase, and Fig. 5 the motor as reconnected with a "T" connection, corresponding to the schematic diagram, Fig. 3.

The principle of the Scott connection is well understood and explains the reason for omitting the coils in one leg, as indicated. It may be of interest, however, to consider what would happen if these coils were not omitted. This is indicated in the voltage diagram, Fig. 6; *BD* represents the voltage generated in the phase

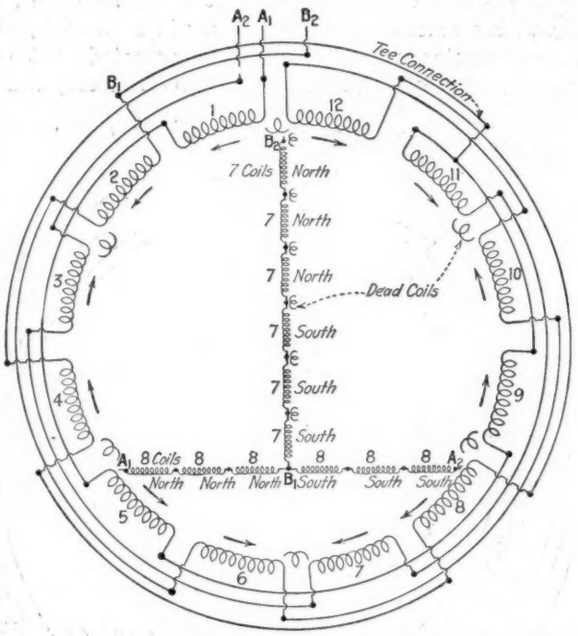


FIG. 8. SIMILAR TO FIG. 5, EXCEPT THE NORTH AND SOUTH POLES ARE ARRANGED TO GIVE A BETTER ELECTRIC AND MAGNETIC BALANCE

B_1B_2 of Fig. 3, by the rotation of the magnetic field and AC the voltage generated in the phase A_1A_2. The result is three perfectly balanced voltages AB, BC and CA, which correspond to the voltage of the line in the three phases and allow normal operation. If the coils had not been cut out of the B phase, as shown in Fig. 3, the voltage generated in that phase by the rotating magnetic field would have been the same in value as

that in the *A* phase and would be represented by *DE* in Fig. 6. The voltages *AE* and *EC* would then be represented by 111, while *CA* would be 100. This would be equivalent to having one alternating-current generator representing the lines with balanced voltages of 100 each, or *AB*, *BC* and *CA* connected in parallel with another, alternating-current generator representing the motor windings and having unbalanced voltages, *AE*, *EC* and *CA* of 111, 111 and 100 respectively. The result of this would be a component *BE* equal to 14, which would spend itself driving useless wattless currents through the motor windings in an effort to balance properly the voltages and make them equal to *AB*, *BC* and *CA*. The immediate result of this useless current would be to increase the heating of the machine and decrease its torque and efficiency and power factor.

It is characteristic of an induction motor that it always makes this attempt to balance by circulation of wattless current any eccentricities either existing in its own windings or in the circuit to which it is connected. At times when such eccentricities exist in the stator winding, there will be wattless currents flowing in the rotor winding trying to correct them through the medium, always, of the rotating magnetic field. At other times when a power circuit of relatively large power is somewhat unbalanced and is connected to an induction motor, the motor will take upon itself the burden of correcting the dissymmetry of the entire line with disastrous results to the motor from overheat due to excessive corrective currents, although the motor may have been running idle at the time and developing no actual power. This explains why the coils are cut out of one phase, as shown in Fig. 3.

Poor Results of the "T" Connection

The reason for the comparatively poor results on the "T" connection, as shown in the table, is that the motor was connected as shown in Fig. 5. The result of this connection, if the air gap was not absolutely the same all around the rotor, would be to make *AD* and *DC* in Fig. 6 unequal; and a voltage diagram, as shown in Fig. 7, might result. When the voltage triangle *A'B'C'* of Fig. 7 is connected in parallel with the symmetrical line triangle represented by *ABC* in Fig. 6, the result is that corrective currents will flow and these corrective currents pull down the performance, as shown in the table. A much better connection is the one shown in Fig. 8, since this will have a tendency to keep the point *D* in Fig. 6 in the middle of the side *AC* and not let it be moved to one side, as in Fig. 7.

A comparison of Figs. 5 and 8 shows that in Fig. 5 the half legs A_1B_1 and B_1A_2 of the *A*-phase, represented by *AD* and *DC*, Fig. 6, each contain both north and south polar groups, while in Fig. 8 the half leg A_1B_1, represented by *AD*, Fig. 6, contains only north poles and B_1A_2 only south poles. The result of this is that if the rotor is displaced slightly in the stator bore from any cause, when the motor is connected as in Fig. 5, it may narrow the air gap opposite to B_1A_2 and widen it opposite to A_1B_1, which means the field will be stronger opposite B_1A_2. Consequently, the voltage generated in this section will be greater, as represented by *D'C'* in Fig. 7. However, when connected as in Fig. 8, no matter if the rotor is near the stator at some point, it cannot affect any north pole without affecting the corresponding south pole, since all the lines of force that start out from a north pole must return through a south pole. Since the legs A_1B_1 and B_1A_2 are so arranged that one has all the north poles and the other all the south poles, this means that they will be affected exactly alike by any displacement of the rotor, and the voltage in the two sections will be maintained equal as represented by the lines *AD* and *DC* in Fig. 6. Therefore, in connecting a two-phase motor in "T" for operation on three-phase a diagram similar to Fig. 8 should be used, in which case the three-phase results will be much more favorable than shown in the table.

The statement has been made above that the winding of a normal two-phase motor has approximately 25 per cent. more turns in series than the corresponding three-phase motor. This is, of course, true only if the turns are all in series in either case and the three-phase motor is arranged for connection in series star. If the three-phase motor under consideration is connected delta instead of star, it should be thought of as a star-connected motor at a corresponding voltage before reducing it to terms of a two-phase winding. For example, if a motor is connected series delta for operation on 220 volts, it could be reconnected series star and operated on $1.73 \times 220 = 381$ volts; or connected for two-phase, it would be suitable for approximately 80 per cent. of 381 volts, or 305 volts. It will thus be seen that a delta-connected three-phase motor when reconnected for two-phase has about 38 per cent. more turns in series than are actually required, and this condition will have to be balanced up by some one of the various schemes suggested.

In general, manufacturers prefer a star to a delta connection, for the reason that the delta connection requires 1.73 times as many turns for the same operating voltage and these turns are of a correspondingly smaller-sized wire. The greater number of turns of smaller wire is an objectionable condition for several reasons, among which may be mentioned that more space is occupied in the slots by insulation, leaving less for copper; the coils mechanically are less rigid and self-supporting; the smaller-sized wire costs more per pound and the same number of pounds are required; and it is more expensive to wind a coil with a greater number of turns. For these reasons, if there is no other good reason to the contrary, a three-phase winding is apt to be arranged for star connection.

It is claimed that investigations made by a subdepartment of the Ministry of the Interior establish the fact, says *Power House*, Toronto, as reported in *Engineering* (London), that in the Saskatchewan River, with its tributaries, and in the Winnipeg River and other streams emptying into Lake Winnipeg, there is hydroelectric energy sufficient to harness 1,172,000 hp. In their upper reaches the Athabasca, Peace and Churchill Rivers, with a number of other large streams, afford new sources of energy equivalent to at least 5,500,000 hp. Manufacturing, it is expected, will, after the war, take on new life at Calgary, within 100 miles of the Selkirk range of mountains. The Bow River, from which 31,000 hp. has been drawn, has at least 75,000 undeveloped reserve horsepower.

The Form of Boiler Drums

By ROBERT CRAMER
Engineer, Kingsford Foundry and Machine Works, Oswego, N. Y.

The structurally weakest part of conventional boiler designs is usually the drum. Its large diameter does not permit a higher factor of safety than about five, without making the thickness of the wall of the shell too large to permit the latter to be produced at a reasonable cost. The present tendency toward higher steam pressures makes it desirable to inquire into the factors which make for strength and endurance of boiler shells. The following discussion is intended to deal mainly with one of these factors—that of the most suitable shape.

BOILER shells are, in the majority of cases, made in the shape of cylinders, the ends of which are closed by means of spherical heads. In order to equalize the stress in these two principal parts, it is customary to make the radius of the head equal to the diameter of the cylindrical part. Where the two parts join, the sharp corner is avoided by the use of a comparatively small "corner radius." There are in this shape two points where the curvature of the shell wall changes abruptly, and it has been pointed out by different writers that the highest stresses are likely to occur at these two points. The reasoning which leads up to this view is based on the assumption that the thickness of the wall of the shell is so small, compared with its diameter, that it can be considered as a mere skin. Expressed more precisely, this means that the resistance which the shell offers against bending is small when compared with that which it offers against tensile strain; therefore, with small deformations, the stresses will be uniformly distributed over the thickness of the shell wall.

As this reasoning is not often referred to in textbooks, a brief outline of it should be of interest. Let it be at the same time stripped of the highly mathematical dress in which it is usually presented. The use of a little algebra, however, cannot be avoided if the matter is to be made at all clear.

Referring to Fig. 1, which represents one end of the boiler shell cut in two by a conical surface at right angles to the shell, let the radius of the circular cut at the center of the shell wall be denoted by the letter r and the angle which the cutting surface makes with the axis of the shell, by A. If the internal pressure in the drum is P, and the thickness of the shell T, then the stress at the cut, if equally distributed over the thickness of the shell, is

$$S_1 = \frac{P}{T} \times \frac{r}{2 \sin A}$$

The factor $\frac{r}{\sin A}$ which for reasons to appear later will be denoted by r_2, is the length of the side of the cone which served for the cut, or in other words, the length of the normal from the point of cut to the axis of the drum. This length is proportional to the stress

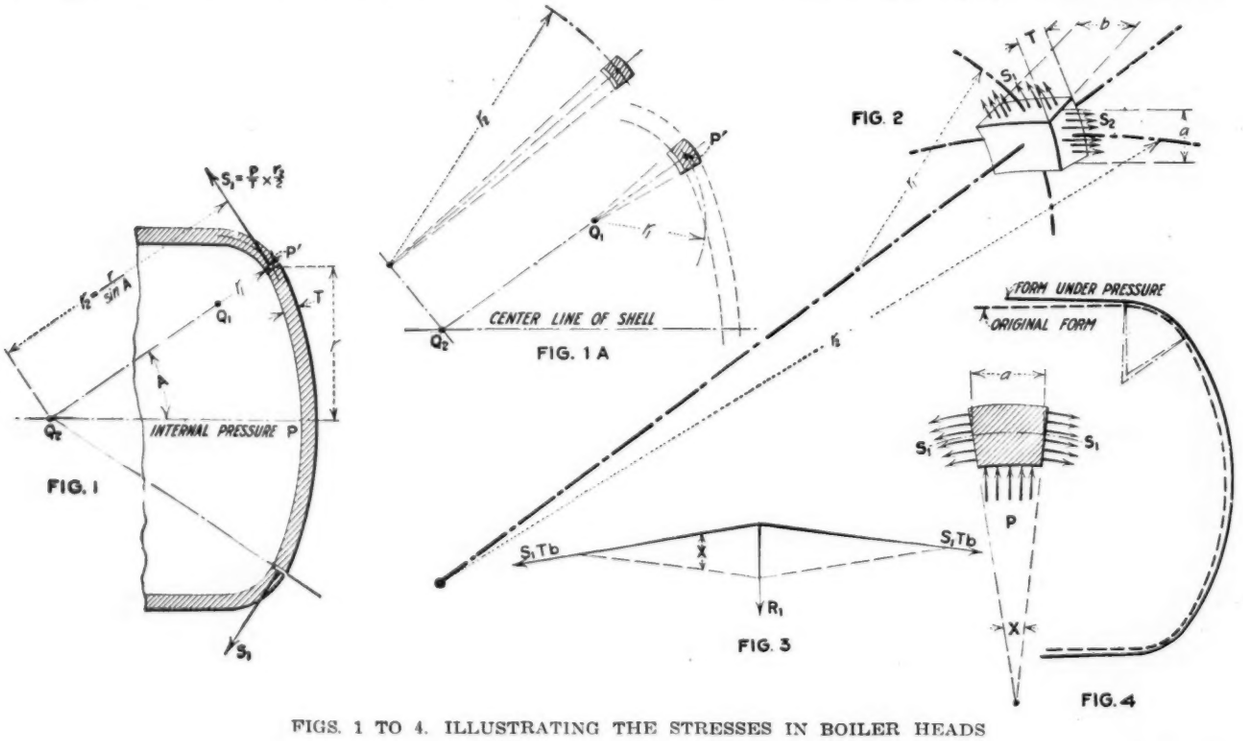


FIG. 1 FIG. 1A FIG. 2 FIG. 3 FIG. 4

FIGS. 1 TO 4. ILLUSTRATING THE STRESSES IN BOILER HEADS

S_1 and is a direct measure of this stress in a scale which depends only on P and T. The stress S_1, therefore, whatever the form of the shell, will always change gradually from point to point, and the rate of change will also be gradual provided there is no "kink" anywhere in the outline.

Imagine now the shell cut by a plane that is tangent to the cone. The line of intersection of this plane and the shell will be a curve, but the radius of curvature of this line at the point where plane and cone touch is equal to r_2. This is a geometrical truth which can easily be verified, and the proof of which hardly belongs here. The other radius of curvature, in a plane at right angles to the one just considered, is the one belonging to the outline of the shell, and denoted by r_1 in Fig. 1.

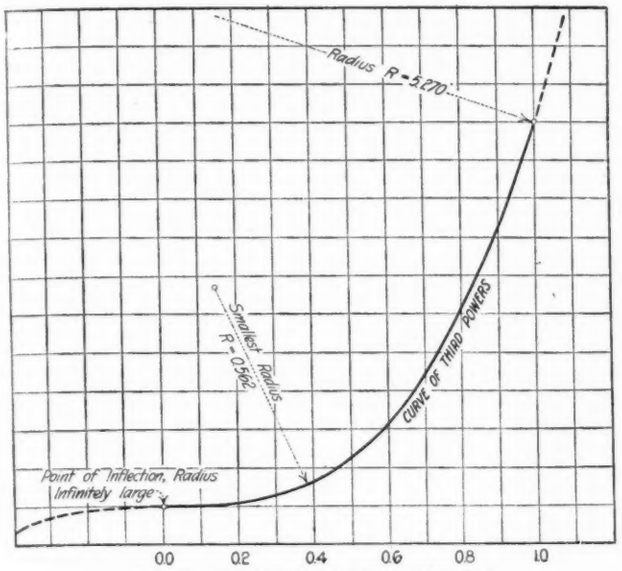


FIG. 5. CURVE OF THIRD POWERS

Let us now consider that we cut from the shell a very small element which contains the point P' (see Fig. 1), at which the cone previously referred to intersects with the outline of the shell. Let this small element be bounded by the inner and outer surfaces of the shell and by four planes, all of which cut these surfaces at right angles. Two of these planes are to be at right angles to the plane in which Fig. 1 is drawn and are to pass through Q_1, the center of curvature of the outline of the shell, denoted by the radius r_1. The two other planes are to be at right angles to a plane tangent to the cone at point P', and to pass through the center Q_2 of r_2, the center of curvature in a plane perpendicular to that in which Fig. 1 is drawn. In other words, r_1 moves in a plane parallel with and r_2 in a plane perpendicular to the surface of the paper. To indicate this more clearly than it can be said in words, the small square element is shown separately in Fig. 1A. This element, having the sides a and b, is shown in Fig. 2. The sides a and b are supposed to be taken so small that the stresses do not change appreciably from one side of the element to the other.

On this small square element five forces are in balance. There is, first, the force due to internal pressure, which is Pab. On two of the sides act the forces due to the stress S_1, which are S_1Tb. On the two sides at right angles to these act the forces due to the stress S_2, equal to S_2Ta. The diagram, Fig. 3, shows how the two forces due to S_1 are combined into one resultant force R_1, which, on account of the equality of the two angles X, can be found from the proportion $R_1 : S_1Tb :: a : r_1$, from which $R_1 = \frac{S_1Tba}{r_1}$. Similarly, the resultant of the forces due to S_2 is found to be $R_2 = \frac{S_2Tab}{r_2}$. The sum of these two resultant forces must be equal to Pab. Hence the equation,

$$Pab = \frac{S_1Tba}{r_1} + \frac{S_2Tab}{r_2}, \text{ which reduces to } \frac{P}{T} = \frac{S_1}{r_1} + \frac{S_2}{r_2}$$

The value of S_1 is already known to be $\frac{P}{T} \times \frac{r_2}{2}$. Substituting the latter in the former gives the value of S_2 as follows:

$$S_2 = \frac{P}{T}\left(r_2 - \frac{r_2^2}{2r_1}\right)$$

It can easily be seen from this that S_2 will change abruptly at any point where two different radii of the outline of the boiler shell meet. The stress S_2 disappears entirely wherever r_1 is exactly one-half of r_2. Where r_1 is less than one-half of r_2, S_2 is a compressive stress.

These statements, however, do not exhaust the obvious interpretation of the results given. Differences in stress are impossible without differences in deformation. Sudden changes of deformation of a boiler shell between adjacent points would mean a rupture, and the foregoing theory would therefore indicate that ruptures must occur, even with moderate pressures, wherever the radius of the outline changes abruptly. We know by experience that such is not the case. What, then, is the correct interpretation? The answer is not difficult.

If the shell is, as this theory supposes, a mere skin, the tendency to a sudden change in stress where two different radii meet will introduce a shearing strain at that point, with the result of a sharp bending of the skin. Such sharp bending, as indicated in Fig. 4, results in an abrupt change, at the point of the bend, of the radius r_2 in the foregoing figures. As the radius

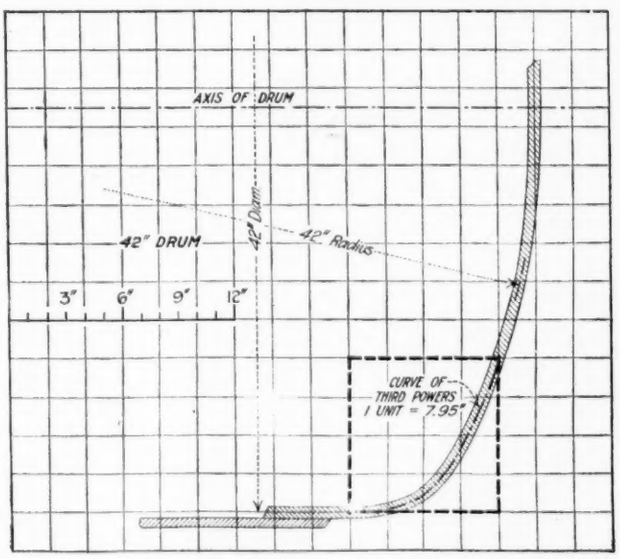


FIG. 6. THIRD-POWER CURVE APPLIED TO THE DESIGN OF A BOILER DRUM

r_2 is the length of the normal of the outline of the shell—that is, the distance from point P' to the intersection of the normal with the axis of the shell—its change as we proceed from point to point along the outline is always gradual as long as there is no "kink" in the outline, even if the radius r_1 changes abruptly at

any point. If, on the other hand, there is a "kink"—that is, if at any point the direction of the tangent to the ouline changes abruptly—the radius r_2 will also change abruptly. This abrupt change of r_2 will adjust itself to the change of r_1 in such fashion that the resulting deformation changes gradually, as it surely must if the skin holds together. An abrupt change of r_2 means, of course, an abrupt change of the stress S_1, but simultaneous abrupt changes of both S_1 and S_2 will, if they are properly proportioned, result in a deformation which is gradual. Thus the adjustment is possible.

If, on the other hand, the boiler shell is not a mere skin, but offers considerable resistance against bending, even though this resistance be small as compared with the tensile strength, a sudden change of r_2 would not be possible without rupture. In this case the tendency to effect the adjustment will result in a high bending stress at the point where the radius r_1 changes abruptly.

An exact estimation of this bending stress is very difficult. For this reason it seems desirable to avoid this bending strain altogether by avoiding sudden changes in the curvature of the outline of the boiler shell. In practical design this important matter is mostly neglected or overlooked, although the condition is not a difficult one to fulfill. All that is necessary is a connection between the cylindrical and the spherical parts of the shell, in the shape of a curve, the radius of curvature of which changes gradually from infinitely large to that of the head. A number of different curves of this character are available, and some of them are not at all difficult to lay out.

Consider, as an instance, Fig. 5, in which the third powers of the numbers from 0.00 to 1.00 have been plotted against the numbers themselves. The continuation of the curve into the region of the negative numbers is also indicated, in order to show that the radius of curvature at the point 0.00 is infinite, this point being a point of inflection. As the curve proceeds from this point, the radius of curvature gradually decreases to the point the abscissa of which is 0.386, where it is 0.562. From this point on, the radius again increases indefinitely. At the point with the abscissa 1.00, the radius is 5.270 and the center of curvature for this point is located almost exactly one-half that length above the axis of the abscissas. This point therefore appears to be suitable for joining the curve to the radius of the head, which is twice the radius of the cylindrical part of the shell.

Fig. 6 shows how this idea is carried out in the design of a boiler shell of 42-in. diameter. The scale of the curve of the third powers is made such that the radius of 5.270 units equals 42 in. The unit is therefore $42 \div 5.270 = 7.950$ in. In practice, where forms for manufacturing the heads have to be made, the adoption of this shape does not seem to me to be a matter of great difficulty. The increased safety of the structure would certainly seem to make it worth while to go to that trouble. It would even seem that in boilers for very high steam pressures, the adoption of this design would permit the use of lower factors of safety than is now customary, and consequently, the excessive cost of high-pressure drums may be reduced.

Other curves may be used to advantage, as for instance the curve of sines, in which the radius of curvature gradually decreases from infinitely large to a minimum and then increases again. The resourceful designer will readily work out applications of the principle in given cases.

The theory that has been outlined in the foregoing would be perfectly applicable in practice if we had to deal with shells that are continuous throughout. But in practical boiler design such shells are not possible. The cylindrical part and the heads of the shell are made separately and joined by means of rivets. At the joint the two parts overlap and the shell is of double thickness. Both stresses, S_1 as well as S_2, are greatly reduced at these points, where consequently the deformation is also reduced. The result is a form which the drum will assume under pressure, as indicated in Fig. 7, greatly exaggerated; consequently the tendency must be toward the development of high bending stresses near the joint.

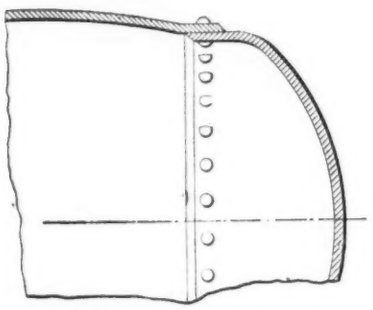


FIG. 7. FORM DRUM TAKES UNDER PRESSURE

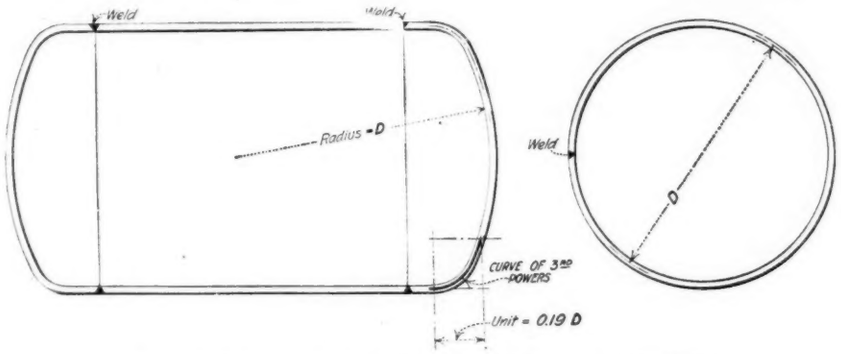


FIG. 8. WELDED DRUM WITH EXCESS METAL REMOVED FROM WELD

It is possible that for high pressures the welded drum is better than the riveted one. Fig. 8 shows such a welded drum, with gradually changing radii, in which the addition of all excess material in the welding process has been avoided, or where the excess material which is unavoidable in autogeneous-welding processes, has been removed. This, it seems to me, is the ideal form of boiler drum, provided it is possible to make the material added in the welding process of essentially the same character as that of the rest of the drum. Recent results with autogeneous-welding processes indicate that this is possible.

Drums in which there is very little bending stress will not be subject to the disastrous effects of fatigue of the metal to the same extent as those in which riveted joints give rise to high bending stresses. In the case of drums with abrupt changes of the curvature of outline, fatigue of the metal will be even more serious, be-

cause in such cases compression may change to tension within rather narrow regions of the wall.

It would be interesting to make comparative tests of drums of conventional design, on the one hand, and on the other hand of welded drums with only gradual changes in the curvature of the outline, so that appreciable bending stresses are surely avoided and the changes of tensile stress are always very gradual.

Causes of Broken Crankshafts

By E. Standiford

Crankshaft failures in gas engines are more common occurrences than is generally supposed. There is often a great deal of contention on the part of the owner that there was a flaw in the material, and in many cases the claim appears to be well founded when superficial appearances only are considered.

In about 70 per cent. of such cases the break shows that at least a portion of the shaft's diameter had been parted for some time. In other words, there are indications of an old break of from one-half to two-thirds the diameter of the shaft, the remainder showing a fresh break. The old break often has the appearance of never having been united. With this condition of affairs the owner is apparently justified in claiming that the shaft was defective and he should receive every consideration that justice and fairness demands, but the real condition that leads to and causes the break should not be lost sight of. In a large majority of cases, broken shafts are the result of loose or misaligned journal boxes.

Crank Shaft Bearings Often Neglected

It is not an uncommon thing to see an engine in operation with the crankshaft jumping in one or both journal boxes at each impulse of the piston. It may have been noticed by the operator but lightly regarded, as in his opinion it is only a trivial matter and oftentimes the condition of the boxes entirely escapes his notice. It is easy to see how loose boxes may result in broken shafts, for in the first place consider the heavy flywheels that are necessary, on a moderate-speed engine of the single-cylinder type, to get steady speed and the best results. If properly carried by the shaft, they really tend to prolong its life rather than otherwise.

Broken crankshafts would be comparatively rare if the journal boxes were more carefully looked after and kept properly adjusted. The purpose of boxes is to carry the revolving shaft and keep it in perfect line, but this cannot be accomplished on a gas engine unless it is carefully and snugly adjusted all the time. The sudden force applied to the piston, and through it and the connecting-rod to the crankshaft, tends to lift the shaft out of its journal box at each impulse, when the engine is turning over, even with the weight of the heavy flywheels holding it down. If the boxes are snugly fitted this lifting motion cannot occur; on the other hand, if the box caps are loose, each impulse raises the shaft and wheels, and as soon as the force of the impulse subsides the weight brings it down again with a thump.

If only one box is loose and the other one is properly adjusted, the loose end of the shaft only will jump, throwing it out of line at each impulse. This condition is even worse than when both boxes are loose, and with the pull of the belt and the weight of the belt pulley added, the cause of a great many breaks can easily be explained.

Effect of Loose Bearings Is Cumulative

As intimated, a shaft seldom breaks all at once. The conditions that cause the break have been in existence and started the trouble a long time before the final complete rupture comes. The unintentional and undue strain on the shaft every time it jumps in the boxes and this continual heavy strain at regular intervals soon cause a crystallized condition in that part of the shaft where the greatest strain occurs. This crystallization usually begins at a point on the outer circumference of the shaft and travels toward the center. It does not necessarily—and in fact seldom does—affect the entire circumference. At this fragile point, then, a crack is started and as the crystallization grows the crack grows deeper until finally the good metal remaining, no longer able to withstand the strain, breaks. When the broken ends are examined, the fresh break shows only as far as the good metal held on. The original crack may have been started months before, and the constant motion caused the broken parts to rub together until they appear as if they had never been united. Many times the owner of the machine uses the expression, "That was never welded properly," or "The shaft was only partly welded." The common opinion or supposition that crankshafts are welded together is ill-founded. Cranks are generally either drop-forgings or steel castings or made by cutting them out of solid steel billets, and no welding process whatever enters into their formation.

In one case three shafts in one 25-hp. engine broke within one year, all at practically the same point. The conclusion was that some unusual condition about this engine was to blame, and upon investigation it was found that a special length was required in the shaft for the purpose of accommodating an extra-heavy and wide belt. An extension shaft was coupled to the end of the regular shaft and an outer bearing supplied. The outer bearing was found to be out of line with the engine, and in order to run with cool boxes the operator concluded he must have very loose bearings, with the result already stated.

A Safety First Move

A jumping shaft always evokes, in the writer, an immediate desire to get out of the engine room and as far away from it as possible, yet how many will tell you that they have operated engines with loose boxes for a long time. Others are as particular to have the journal boxes of their engines properly adjusted as they are to have a good igniting spark.

Another frequent cause of crankshaft failures is ignition, which results in pounding in the cylinder. Ignition in these cases comes before the piston has completed its compression stroke, and the force resulting from the explosion tends to reverse the piston instantly, but the momentum of the flywheel is sufficient to overcome this force. The result of this clash of forces is an extra strain on the crankshaft, which, if allowed to continue for any length of time, can only result in serious damage to the crankshaft and other parts of the engine.

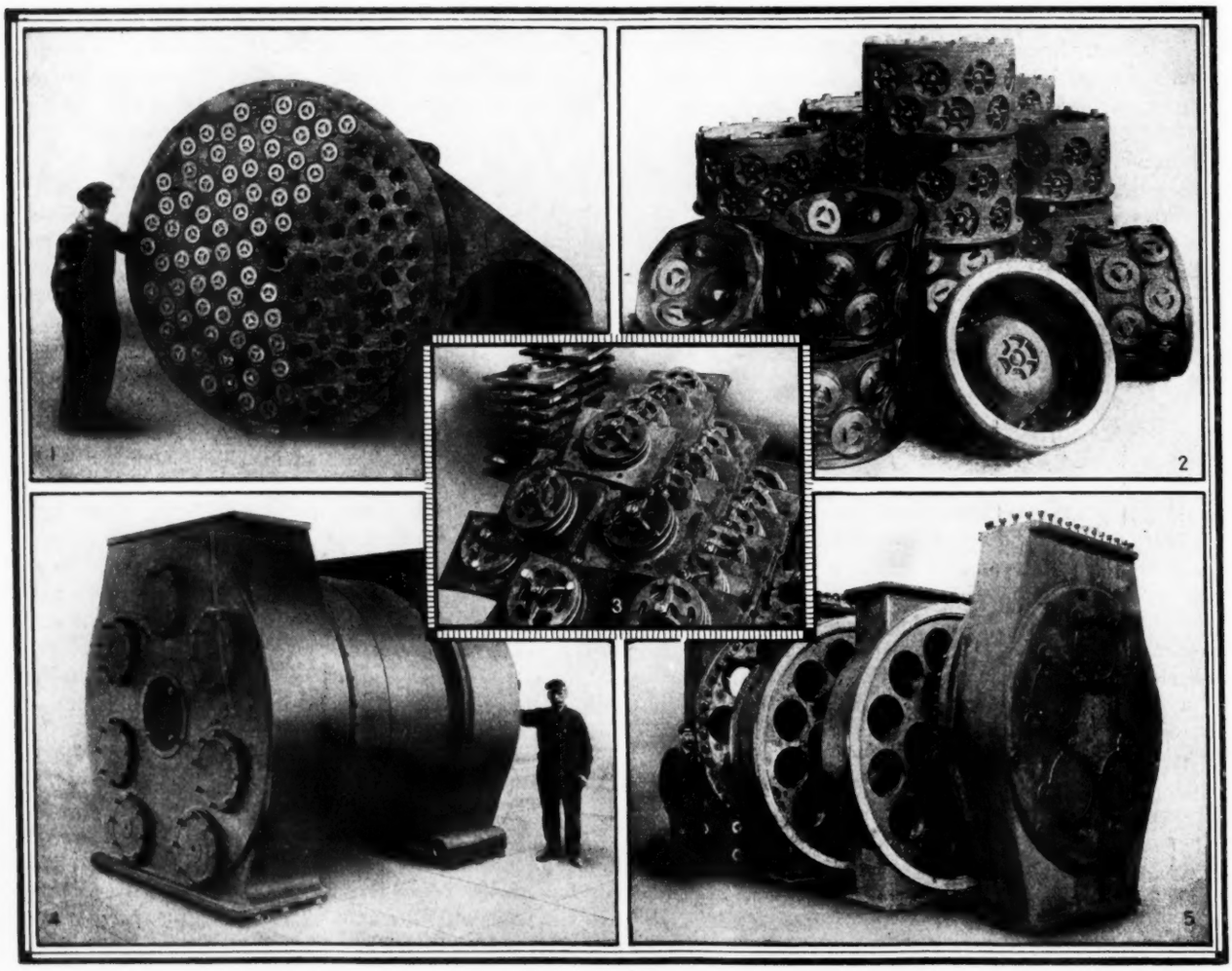
The crankshaft is an extraordinarily vital as well as a costly part of the engine, and it is therefore important that every owner and operator should see to it that anything tending to affect it adversely and that is detrimental to smooth running should be promptly remedied. It is especially necessary to give a reasonable amount of attention to wrist crank and journal boxes to see that they are in snug adjustment and properly lubricated.

Recent Developments in Blast-Furnace Blowing Equipment

Blowing engines in the course of development have followed rather unexpected lines. By comparison of the number of new furnaces built with the number of new blowing engines and new turbo-blowers installed, it is found that a comparatively small amount of new blowing equipment has been added. This surprising result is explained by the fact that a large number of existing blowing engines have been rebuilt in such a way as to have a larger capacity and to serve a greater number of furnaces than heretofore. The possibility of increasing the capacity of existing blowing engines is largely due to the increase in piston speeds made possible by the introduction of plate valves, which have been mentioned before in the columns of *Power*.

The so-called rebuilding of blowing engines is in some cases limited to the simple replacing of the existing valves by automatic plate valves. In other instances it means the removing of old cylinder heads and replacing them by heads containing plate valves. In the most extreme cases it means the removal of the whole air end including the air cylinder.

An illustration of the methods employed in replacing valves of an old type by plate valves is shown on Fig. 2, from a photograph of some done by the Mesta Machine Co., of Pittsburgh. The plate valves are arranged in cages, which take the place of large poppet valves, originally operating in the head. The cages are dished in order to reduce clearance to a small amount. In many cases the clearance volume is smaller than it was with the original valves, while in others it is increased slightly, depending on the type of valves being replaced by the cages. But even in this latter instance the advantages gained by the instantaneous opening of the valves and the larger area secured, are such as to overbalance the slight increase in clearance volume.



FIGS. 1 TO 5. PLATE VALVES AND THEIR APPLICATION TO AIR CYLINDERS

Fig. 1—Placing plate valves in existing valve head. Fig. 2—Plate valves ready for replacing old type of valves. Fig. 3—Valves to fit segmental arrangement of old valves. Fig. 4—An entire new air end. Fig. 5—New air heads

Fig. 3 shows how valves have been made to fit a segmental arrangement of old valves. Fig. 1 illustrates the method of installing valves in place of existing valves in the head. This latter method as a rule gives some increase in valve area, but not enough to warrant

increasing the speed of the engine materially. This method is to be recommended particularly in the case of old blowing engines equipped with leather valves. The advantage is claimed that the plate valves are always tight and in consequence deliver more air, whereas leather valves soon begin to leak, owing to warping or charring of the leather, and a higher pressure can be blown.

The second method—that of replacing old air heads with new ones—is widely practiced at the present time. Fig. 5 shows the appearance of such air heads. The third method is that of replacing the old air end, but it has been necessary only occasionally. Fig. 4 shows the appearance of such an air end.

Plate valves allow higher piston speeds, and this feature is beneficial in several ways. Right now, because of the poor grade of coke available, many furnaces are troubled by the necessity of more air than was used in the past when better coke was obtainable. Increasing the supply of air has pulled several furnaces out of a bad predicament.

Ventilating Cable Manholes

By R. K. Long

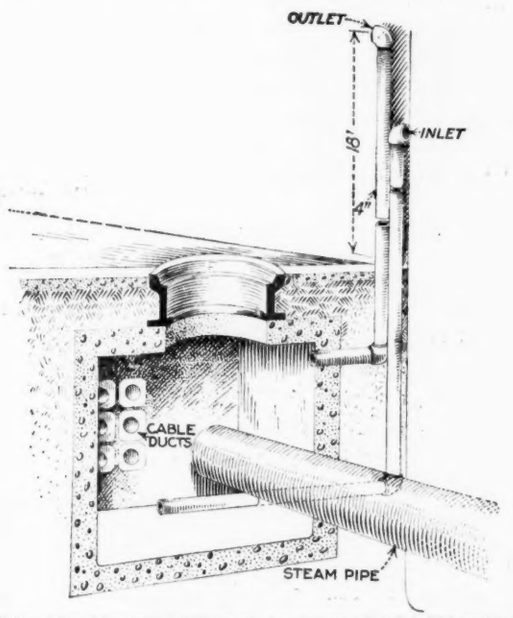
In installing underground electric cables in the streets of cities, manufacturing centers, etc., the route that must be chosen on the score of minimum installation cost is one that also represents the most convenient route for gas, water, sewer and steam-heating pipes. It thus often happens that electrical cables must be run in close proximity to steam-heating pipes. While gas mains are always objectionable when close to electric conductors, because of the possibility of gas leakage causing explosions and also chemical action upon the conductor sheath, steam-heating pipes offer even greater objections. To begin with, frequently the heat radiated from steam pipes heats the earth around the outside of the electric cables, thereby increasing their operating temperature, which in turn reduces their current-carrying capacity. Then again, while thermometer readings in manholes show that the steam pipes are in good condition, here and there the insulation may be deteriorated and hot spots exist without being suspected, as a result of which breakdown may occur in electric cables when heavy loads are being carried. Other objections to having steam-heating pipes near underground electrical cables are that repairs to these pipes are periodically required, which means possible disturbance and damage to the cables; while ruptured pipes, corrosion from condensation, etc., have always to be contended with.

One recent instance came up in a large industrial plant where underground cables had to be installed in existing cable ducts, in close proximity to steam-heating pipes, which had been laid since the duct was put in. The electrical cables were installed during the summer when no steam heat passed through the heating pipes, since heat was required only during the cold months. All went well until the cold weather set in, then cable failures began. At first the cables had been about three-quarters loaded, but the load had grown until they were required to carry about 15-per cent. overload.

Even at the lighter load breakdowns had become so common that an investigation was made to find the cause. Measurements in the manholes by means of thermometers against the lead sheaths of the cables showed that a temperature was attained that exceeded the safe limit even with less than full load on the cables. One week end, with no load on the cables but steam on the pipes, showed that the heat radiated from the steam pipes was the cause of the high temperature. It was the high ambient temperature of the earth round the cables in addition to their heating under load that undoubtedly caused failure of the insulation.

It was realized that the steam pipes ought to be reinsulated, but to do it during the winter was out of the question. On the other hand, great industrial activity necessitated carrying more load on the underground cables. The problem entailed as the important factor rapidity of results rather than economy of financial outlay. The solution divided itself into three categories: To decrease the radiation losses of the steam pipes and therewith the high ambient temperature of the earth round the cables; to increase the current-carrying capacity of the cables, a matter requiring pulling additional cables in ducts that were already installed; to find a means of dissipating the heat losses of the pipes more rapidly.

As already pointed out, reinsulating the steam pipes could not be considered, and even were it done, the result would be largely a matter of experiment. To pull additional cable in ducts that were already in place might suffice, but was an extravagent solution that hardly followed sound engineering practice. Moreover, cable prices were high and guaranteed delivery impossible to obtain, hence this method of solving the problem was eliminated. The most promising and cheapest way out of the difficulty appeared to be to reduce the temperature round the cables by some method of forced or natural cooling or ventilation.



PIPE ARRANGEMENT FOR VENTILATING MANHOLE

Forced ventilation first presented itself, because it permitted of variation according to the need. On the other hand, forced ventilation would represent a con-

tinual outlay of energy and high initial investment. Delay was also to be expected in obtaining the fan and motor to suit the case. Natural ventilation offered the greatest advantages—low cost, minimum cost of upkeep and attention and long life—if only a method could be found for accomplishing it.

The cable ducts had been installed of standard size, while the cable then installed was capable of caring for present needs. The result was that there was ample space in each duct between it and the cable for the circulation of air. A number of the ducts had no cable in them, this assisted still further the passage of air through the ducts. It is a common custom to use manhole covers with outlets in them, and while these are of a certain amount of use, the outlets are very inefficient since air cannot enter and leave by the same outlet. The covers in the manholes were, however, not considered in the problem.

As shown in the figure, at each manhole two sections of steel pipe were installed, one to act as inlet, the other as outlet. The amount of air circulating depends largely upon the temperature difference between the outside air and the inside air, in the same way that it does with the chimney of a boiler. Four-inch pipe was used, the inlet pipe reaching up 6 ft. and the outlet 18 ft. above the surface of the ground. It should be noted that the incoming air passes first round the cable from the bottom up, then past the steam pipe and out to the atmosphere. Also in this case the wind blew almost continually from one direction, coming inland from the lake. To make the influx of air still more positive, the elbow of the intake was directed so that the air tended to blow in, while the elbow of the exhaust pointed in the opposite direction so that the wind tended to suction the hot air out. Of course these influences of the wind were very slight, but the attention to detail indicates the wisdom of taking advantage of everything.

This simple and inexpensive method of getting rid of the heat radiated by the steam pipes overcame the cable breakdowns and at the same time permitted operating the cables at a greater load.

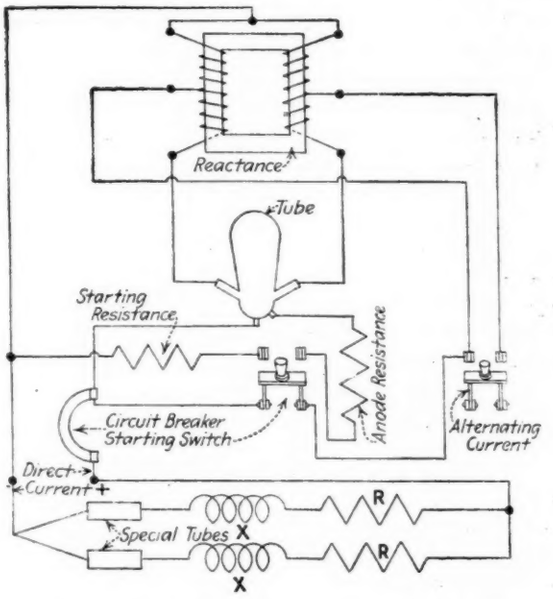
Reactance Cut Out

By E. C. Parham

The current of a mercury-arc rectifier is sufficiently smooth to satisfactorily perform all the duties assigned to it, but at ordinary commercial frequencies the flow of the rectifier current cannot be as smooth as that due to a dynamo, because the frequency of undulation of the former is limited by the frequency of the alternating-current source. On that frequency depends the number of direct-current pulsations per second and their closeness together, therefore the definiteness of the peak of each individual pulsation. It follows, then, that although a device may operate perfectly satisfactorily from a rectifier that is supplied from a 60-cycle circuit, it may not operate satisfactorily when the rectifier supply is changed to 40 cycles.

An industrial chemist had occasion to frequently operate two special-type mercury-arc lamps in parallel from a mercury-arc rectifier, as shown in the diagram. He complained that the outfit was inoperative because the rectifier-load circuit-breaker opened whenever the load was transferred from the starting resistance to the lamps.

An inspector investigated and found that operation had been entirely satisfactory up to the time the location of the outfit was changed. In making the change the connections had been arranged so as to cut out one of the reactances X and X, which had been cut in at the



WIRING DIAGRAM OF RECTIFIER AND LAMPS

time the rectifier was changed from 60-cycle adjustment to operate on 40-cycle service, the main object of the reactances being to flatten the peaks of the 40-cycle current. Also the reactances with the resistance R and R limited the maximum value of the current drawn by the mercury lamps when being started. Therefore, with a reactance cut out, the initial current flow through the lamps would blow the circuit-breaker and shut down the rectifier.

Replacing Glass Oil Gages

Large generator bearings and other machine bearings made several years ago with exposed and unprotected gage glasses to show oil level constantly invite danger of shut-down owing to breakage of these gage glasses and consequently a burned-up bearing. There is little advantage in having an 8-in. or 10-in. (20.3-cm. or 25.4-cm.) glass to show the level of oil. A brass pipe having a small opening at one side of the proper oil level, with a short piece of gage glass cemented or puttied inside the pipe at the opening, is preferable. This will show the correct height of oil to be carried and will eliminate the danger of a cracked glass causing trouble.

This idea was brought out by O. N. Wiswell of the Puget Sound Traction, Light and Power Co., Seattle, Wash., at the tenth annual meeting of the Northwest Electric Light and Power Association at Spokane. —*Electrical World.*

Those who make worth-while contributions to world usually have a welcome sign over the door.

Editorials

Do Not Criticize the Code, but Be Guided by It

PREVIOUS to the promulgation of the National Board of Fire Underwriters' Code by the various insurance companies and interests in the electrical industries in 1897, electrical installations were in most cases of a character other than that which would do credit to the industry. There being no prescribed standard, electrical work was done to suit each individual's ideas. Unfortunately, these ideas generally ran toward the cheapest kind of materials and workmanship. It is to be granted that present-day materials were not to be had twenty years ago, but the best use, with exceptions which were usually the central stations, was not made of the materials that were obtainable. However, with the introduction of the electrical code a great many of the early abuses have been eliminated, especially in the large towns and cities. Occasionally today in a rural district, where the central station is not overparticular about how the customer's installation is made, and where the code is not rigidly enforced, there can be found examples of wiring to the individual taste, which bring to the mind what the conditions would be if the frequently criticized code did not exist.

Probably if there is one thing more than another that has given impetus to the manufacturer of electrical materials, it is the National Board of Fire Underwriters' Rules. These rules have made it possible for the electrical manufacturers to develop a superior material with an assurance that, after passing the tests of the Underwriters' Laboratories, it would be adopted as a standard. As the improved materials have been developed, the inferior fittings have been disapproved and dropped out of use.

Since all materials used in electrical construction must be approved by the Underwriters' Laboratories, the purchaser is protected against materials that are unfit mechanically and electrically. Yet with all the improvements that the code, in a certain degree, has been responsible for, some of the criticisms that it receives would almost lead one to think it was one of the worst plagues that could have come upon the industry. It is not always the code that is the cause of the criticism, but sometimes the men that enforce the various rules, as it must be remembered that these men are not infallible. When a piece of work is condemned without any explanation other than it must be done so and so, if the workman who is doing the job is making an honest effort to meet the requirements, this sort of ruling may create antagonism and the feeling that he is being imposed on. On the other hand, if the inspector explains the reason for the ruling and that the object is to obtain the best possible construction and eliminate hazards to life and property, the prospects of securing the coöperation of the man making the installation is manyfold increased.

The recent revision of the National Electric Code at the meeting of the electrical committee of the National Fire Protective Association again reminds us that the code is not an inflexible body of laws that have been handed down to us from the dark ages, but represents the matured opinion gained during many years of experience by those in the electrical industry. At the beginning of 1918, when the new code is issued, we will have taken what may be considered another important step forward in the installation of electrical equipment. The code as then revised will represent the best opinion to date of the electrical-manufacturing, contracting, central-station and insurance interests in this country on electrical construction and appliances; therefore it is worthy of everyone's consideration in an endeavor to adhere to its mandates.

The Form of Boiler Drums

TRUE theoretical knowledge and true practical knowledge are essentially the same. An engineering theory, to be of any value, should be nothing else but an exact and systematic statement of practical facts. What is usually understood under the term theory is the mathematical expression of the relations of certain practical facts, and such a theory is or is not of value as it does or does not correctly express such relations.

The article on "The Form of Boiler Drums," appearing elsewhere in this issue, is a case in point. As demonstrated in this article, the consideration of the deformation of boiler drums under pressure leads to the conclusion that abnormally high bending stresses in such drums can be avoided by avoiding abrupt changes in the curvature of the outline of the shell. However, by logically continuing this argument the conclusion is reached that riveted joints, with their stiffening effect, must also be avoided, and that the wall of the drum should be made continuous, without any joint, and of equal thickness throughout.

The only possible manner, at the present time, of practically executing this idea involves the use of autogenous welding. And here we meet the practical fact, which the theory leaves out of consideration, that the welding process may leave the material in the neighborhood of the weld in a condition in which its elastic properties are essentially different from those of the rest of the shell. Only practical experience can give the final answer to the problems involved, and carefully conducted experiments to that end would seem desirable.

It may appear that the change advocated in the article referred to, from the "corner radius" to a line of gradually changing curvature, means such a slight departure in the form of the drum as to be of relatively small importance. There are, however, many instances in practical machine design, where seemingly slight differences in form are of the greatest conse-

quence. A large casting, for instance, must have fillets where walls join at right or nearly right angles, or cracks will surely result. Often an insignificant-looking fillet will prevent trouble of this kind. The same is true of shoulders where diameters suddenly change in engine or turbine shafts. As higher steam pressures are adopted, the question of gradually changing curvature in the outline of boiler drums may well become one of great importance.

To Earn More, Learn More

SOME of our recent correspondence has condemned the "Learn More, Earn More" plan because it has not been immediately effective in raising wages. Increased proficiency does not spontaneously bring a raise in wages. One way in which it may be expected to work is indicated in the following experience of a former operating engineer now employed by a group of business interests as an administrator and technical adviser.

When a young man he was employed in a plant operated by a syndicate of national reputation. Soon his responsibilities were extended to the supervision of another plant in the same district controlled by his principals, and a little later he was requested to take general charge of all the plants in the territory connected with the system, which has since been consolidated into one operating organization. Here experience was the main reward; the salary was anything but commensurate with the responsibilities, and the thrifty syndicate required its rising young technical expert to pay his own traveling expenses on his periodical trips to the headquarters office. Yet for several years the opportunities of the work justified the acceptance of the meager salary; then, when it was seen that a routine future lay ahead, with little prospect of financial advancement, a change was made.

This time the hero of this sketch took charge of the mechanical and electrical plant of a large metropolitan department store. From a post which required frequent trips from city to city he stepped into a position where a world of engineering activity was encompassed within the four walls of his employer's establishment. Long hours of intense service followed. Compensation was good, but again, experience was better. The variety of work was simply extraordinary. Efficient service led to the request of the employer that an elaborate system of plant accounting and tests be instituted, and it was done. Development work came along so fast that the engineer in charge was forced to employ a draftsman to assist him in his own office. The more ability he displayed, the more his employers called upon him to do, but we are not advised that his compensation rose accordingly. The experience was admirable, but the time came when the chief of staff in the engineering department was deluged with detail. He and he alone was responsible for all the work done, and the extremely moderate rates of compensation in vogue in the establishment rendered it almost impossible to hire subordinates of sufficient ability to take their share of the burdens.

Had the employer in this case seen the light of a liberal wage scale graduated according to the efficiency of his staff members, the organization might have remained intact to this day. The natural result followed. The chief accepted an opportunity to join forces with a powerful administrative organization as expert engineering adviser and today is reaping the reward of his judgment and his experience. For the compensation received in his present post more intense work is required than in any of the earlier positions, but experience has been capitalized, and the men who recognized the value of such a training and service as this engineer has had and has rendered, are getting the benefit of their liberal viewpoint. There is a lesson for many employers of engineers in this glimpse into a personal history.

Minding One's Own Business

ONE of the most profitable occupations that a man can engage in is minding his own business. He cannot expect to perform the duties of both himself and another. As a matter of fact, a great deal of harm is often done when people fail to live up to this simple precept. In every organization there are meddlers and gossipers who do not seem to have enough to do to mind their own business, but rather, take pleasure in attempting to discredit others.

The man who is continually trying to compromise his fellows is likely to be called upon sooner or later to take a dose of his own medicine. For those who really desire to make a favorable impression, the best thing in the world to do is to attend strictly to business and perform each duty in such a manner that it cannot be criticized.

Frequently the ambitious young man finds the authority of his immediate superior irksome. He fails to see the reason for many of the policies and acts of the chief. There is no harm in such questioning provided his attitude is right. He can talk things over in a friendly way with the chief and often such a talk will be to the advantage of both. But if he should carelessly or maliciously attempt to discredit either the chief or his own associates, such action is sure to result in ultimate disaster to himself.

It is surprising what a large amount of thought and study may profitably be put on the operation and equipment of a plant. Even the simplest piece of apparatus deserves constant study and intelligent attention. The man who can suggest and put into operation one money-saving plan will be a thousand times more deserving of substantial recognition than one who spends his time uselessly criticizing the management. The really worthy man has no time for such profitless employment.

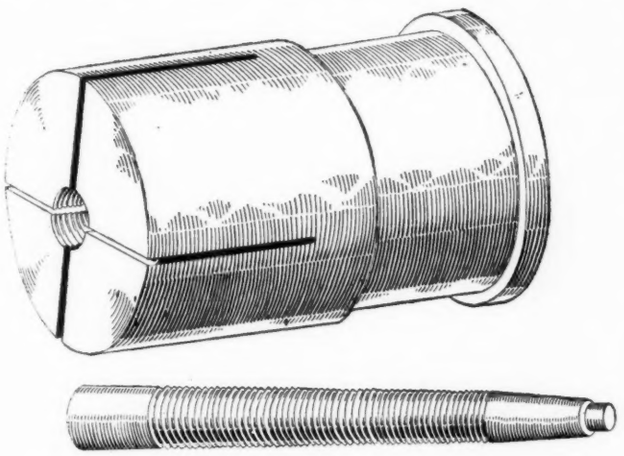
Massachusetts Boiler Rules and A. S. M. E. Code

DISCUSSION of the petition presented by a committee of the American Boiler Manufacturers' Association to the Massachusetts Board of Boiler Rules at its recent semiannual hearing, for changes in the Massachusetts Boiler Rules which would bring them into conformity with the Boiler Code of the American Society of Mechanical Engineers, has revealed the sources and the causes of opposition to this move by the Commonwealth in the direction of coöperation and uniformity. Divested of all considerations of purse, pride and precedence, there is not enough difference in the two codes to keep Massachusetts out of the movement for nation-wide, if not world-wide uniformity.

Correspondence

Loose Crankpin Secured

The letter by H. K. Scholefield in the issue of Sept. 11, page 368, regarding a loose crankpin, recalls an emergency repair job on one of our locomotives. The pin was found, at the weekly inspection, to be loose, and as the engine was badly needed and as stock for a new pin was not at hand and all the machine tools were busy on other work equally important, the repair was made as follows: The pin was forced out of the driving wheel, a one-inch hole was drilled and tapped in its end to a depth of six inches, and two slots five inches deep were sawed as shown. A tapered plug was then turned up and threaded on a small lathe, the stock being an axle from an old automobile, probably a vanadium alloy. The pin was driven into place, the hole and



LOOSE CRANKPIN EXPANDED WITH TAPERED PIN

slots filled with a paste of Smooth-On cement, and the plug screwed in until it twisted off flush.

The time required for the repair was three hours, and the engine has since been in switching service twenty-four hours daily and six days per week for three months, giving entire satisfaction.

A loose pin in a small locomotive crane was treated in a similar manner with equally satisfactory results.

Madison, Ill. H. R. WASS.

Tungsten Versus Carbon Lamps

Regarding the discussion in the issue of Sept. 11, page 365, as to the relative efficiency of carbon and tungsten lamps, it should be remembered that all the electric energy consumed in an incandescent lamp is converted into heat. The filament is heated by the electric energy and loses its heat by radiation, etc., but the temperature of a lamp does not represent the amount of heat developed—only the heat retained.

The nitrogen lamp retains much more heat than the vacuum lamp because of the nitrogen present, therefore it and the filament become much hotter and consequently give more light. The efficiency of the nitrogen lamp is greater because a larger percentage of the energy supplied is converted into luminous rays because of the greater heat of the filament.

Philadelphia, Penn. W. H. NOSTAN.

Failure of Diesel-Engine Crankshaft

Referring to the statement, in the issue of June 5, page 773, by Philip H. Smith, before the Diesel Engine Users' Association, in which he attributes the cause of the short life of Diesel crankshafts to faults of the engineer in charge, saying that "it may be prolonged indefinitely if certain reasonable and simple precautions are taken," and further, "that all the failures he had investigated were due to lack of alignment of the main bearings," I wonder if Mr. Smith is really a practical engineer of Diesel engines, or consulting engineer, or some manufacturer's erector—because he blames the engineer in charge. And I would humbly ask why the webs are the first to fail and why certain webs, of consecutive numbers counting from the flywheel, should fail, if the cause is the misalignment of different bearings, as stated. Mr. Smith, as well as those who are consulted here (in India), seems to be prejudiced, assuming the chief and main cause to be misalignment of the brasses. But when they have such experience themselves, on engines in their own charge, the failures are attributed to "overload" or "an old fracture," and thus prove that the failure and the misalignment theory is not applicable to their case. I once had such an accident to a new 750-b.-hp. four-cylinder engine, 21 1/32-in. diameter and 24 3/4-in. stroke, 215 r.p.m. and direct-connected to a 500-volt alternator. The fracture occurred at the fourth web from the flywheel side.

The engine had worked for only two years and one month, and there had been no trouble with the bearings at any time during the whole run, because they were well looked after and cared for, knowing that others had given trouble and that failures had occurred in such engines without any apparent cause. We used to charge new fresh oil every six weeks besides a fresh charge of 6 to 8 gal. daily, and we had reduced the fuel-oil consumption from 0.75 lb. to 0.67 lb. per kw.-hr. since taking the engine in charge from the manufacturer's erector, for the friction of the engine had been brought down considerably and the bearings were as good as new. All this is not simply to give credit to our staff, but to show Mr. Smith or others prejudiced against the engineer that they should try to find the true cause of the fractures of webs, because it is a serious matter and may be found to be due to other causes than lack of alignment if all the engineers and manufacturers persistently agitate the question and investigate properly, beginning with the right theory. I have seen four crankshafts fractured and all in the webs.

Delhi Gate, Ahmedabad, India. P. P. TALATY

Taking Leads from Bearings

Noting J. Lewis' article on page 299 in the issue of Aug. 28, about taking leads from bearings, it occurred to me that a few notes of the method used in our plant might be of interest. From three to five leads are used, according to the length of the journal, and placed as shown in Fig. 1. A little hard grease or yellow soap is used on the ends of each piece of lead

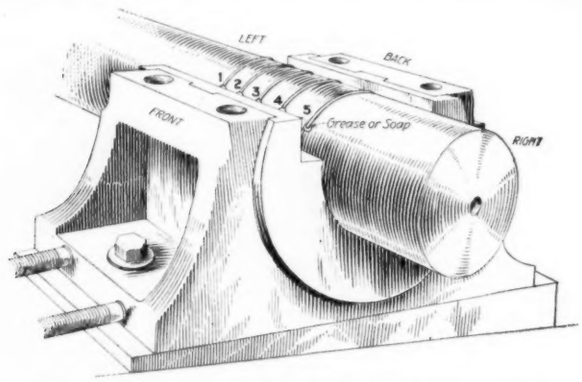


FIG. 1. LEADS IN PLACE READY TO PUT CAP ON

wire to stick it to the journal and insure its remaining in place while replacing the cap. In setting up the bearing caps on a set of leads care must be used that each corner of the cap is drawn down an equal amount

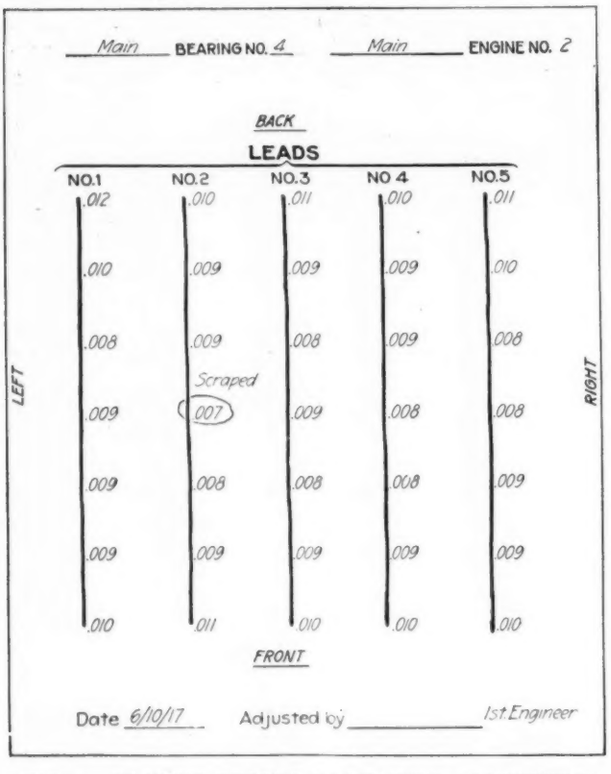


FIG. 2. GRAPHIC RECORD OF BEARING ADJUSTMENT

each time. The use of feelers will help to do this when the bolt nuts are not graduated. In slacking off and removing, the same precautions are necessary to obtain a true lead. When the cap has been removed, the leads are taken up one at a time and their thickness measured (with micrometers) at several places, and these recorded as shown in Fig. 2, setting down the measurements in order, front and back, left and right, of the bearing on the sheet. This is a great aid when scraping. The high or close spots that need scraping are ringed or circled, as shown, and with the graphic sheet close at hand, the workman is able to correctly scrape them down.

The sheets showing bearing adjustments, with date, etc., become a permanent part of the plant's repair log and are accessible for reference when making future adjustments or when trouble is experienced with a bearing that has been adjusted.

C. H. WILLEY.

Concord, N. H.

Locomotive Efficiency

H. S. Vincent is disappointing in his remarks on "Locomotive Efficiency" in the issue of Sept. 25, page 431. As he is presumably a locomotive expert, he should be able to produce more relevant information to bear on my article (issue of May 22, page 709) than he has.

He does not refute my argument, since my main contention—namely, that the combination of mechanical draft and an exhaust-steam feed-water heater would increase "the power that can be developed from a given size of boiler and weight of fuel" by 25 or 30 per cent., and that mechanical draft would permit of still greater economies than are now being obtained from the use of economizers and superheaters—is barely referred to.

The remarkably high rates of heat absorption in locomotive boilers, to which Mr. Vincent directs attention, should be of interest to designers of stationary boilers as illustrating the benefits of high gas velocities and small-diameter tubes. Mr. Vincent objects to my statement, "The high rate of combustion per square foot of grate now used implies a high draft, amounting at times to a suction of as much as 10 in. water column in the firebox." This should read "smokebox."

New York City. GEORGE H. GIBSON.

Condemns Steamboat Inspection Services Rule

I note in *Power* for Oct. 16 an article on the United States Shipping Board's Free Engineering Schools. The rule relative to "experience at sea," about which there has been so much trouble, is unfortunate. It was not and likely is not in accord with the wishes of the Recruiting Service. Although the rule is plainly contrary to United States statute laws and has been specifically decided invalid by the United States Court of Appeals, yet the Inspection Service continues to maintain it, in addition to other obstacles, that it may favor certain classes known to be of and to favor the marine unions.

The article referred to shows that the Recruiting Service is "knuckling" to the Inspection Service instead of making an effort to have the just, fair and liberal United States laws carried out as they were intended and as they should be.

It is a shame that no one has the pluck, nerve and energy to stop this abuse of authority. I wonder if the Recruiting Service knows the true situation or if it is in official ignorance of it.

Syracuse, N. Y. FRANK R. WILLIAMS.

Importance of Large Air-Receiver Capacity

Considerable difficulty had been experienced in operating the compressed-air drills in a certain mine tunnel. The two-stage steam-driven compressor, nominal three-drill capacity (about 275 cu.ft.), delivered air at 90 lb. gage and was located about 3500 ft. from the drills. Near the compressor there was a 30 x 66-in. horizontal receiver good for not over 90 lb. pressure. Near the drills there was another, smaller, receiver. The drop in pressure was so great that frequently only one 90-cu.ft. drill could be operated and even then the pressure would drop to 60 lb. or less and the pipe line would frequently freeze up so that in cold weather it was necessary to traverse the line daily, open up drains and build fires to free the line. Any changes, however, had to be made at small expense.

A 48 x 72-in. receiver designed for 125 lb. pressure was put in place of the smaller and weaker one near the compressor, and the pressure increased to 105 lb. The new receiver was placed in a vertical position and provided with a good drain. The air inlet was near the bottom and the outlet near the top on the opposite side. The old receiver was taken to the tunnel and connected in the pipe line alongside of the other one, thus more than doubling the capacity there.

After these changes had been put in effect, it was possible to operate three drills under ordinary intermittent service in rock drilling and the compressor was not overloaded. Much less trouble has been experienced in freezing up, and the total expense was only about $125. R. S. HAWLEY.

Golden, Colo.

Buying Second-Hand Machinery

In a great many cases second-hand machinery such as engines, boilers and to some extent such small items as clutches, pulleys, etc., has considerable value and, if bought right and of the type and size suitable for the purpose intended, will be found to be a good investment. The principal difficulty is in the selection—accepting what is offered rather than that which is most suitable. The tendency is to accept "something just as good" or "about the right size," especially when the price seems low. This may prove to be more costly in the end than new machinery.

If the transaction is to be a large one, a thorough inspection should be made, and in the case of a boiler it is preferable to have the insurance company that would be asked to carry the insurance inspect the boiler and report its condition before purchasing. The expense is low and is well worth while. In the case of clutches, pulleys and other small machinery found nearby, the cost of inspection by someone competent will be small.

The chief precaution is to buy only what is suitable and to see that it is in such state of repair that the price asked is not out of proportion to its value as compared with new machinery, bearing in mind that no guarantee is given as to workmanship and against defects as in the case of new machines, although it may be none the less reliable. J. C. HAWKIS.

Hyattsville, Md.

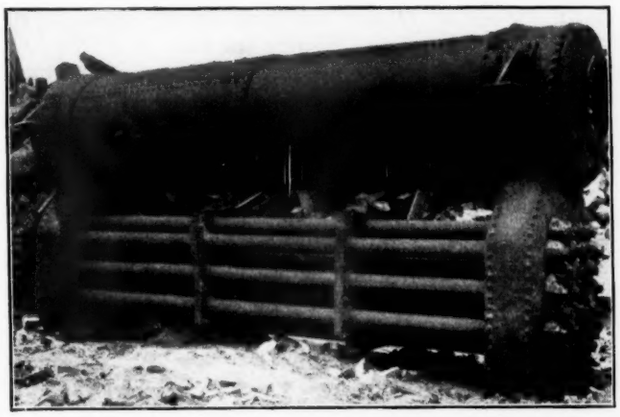
The First Heine Boiler

After a fire destroyed the National Guard Armory at St. Louis, Mo., a few months ago, the Heine Safety Boiler Co., obtained possession of the first Heine boiler built, which was installed at the armory in 1881. This little boiler is shown in the illustration just as it was when removed.

It has 24 tubes about 10 ft. long, and the heating surface is approximately 250 sq.ft., making the rating of the unit 25 hp. It was built in the shop of Richard Garstang, St. Louis, and was originally designed for about 100 lb. pressure. An inspection report from the Fidelity and Casualty Co. reads in part as follows:

> The tubes are pitted and before the boiler can be used, it will be necessary to retube it, also the blowoff flange should be renewed and the boiler completely provided with valves and trimmings if it is to be installed and used further. In the event of the boiler being installed, we could allow a working pressure of 80 lb. per sq.in. [against 100 lb. originally designed for] after the above recommendations have been carried out.

This indicates a somewhat longer life for water-tube boilers than is usually credited to them by accountants or engineers when apportioning depreciation charges. However, under modern conditions the heavier loads on boilers would perhaps tend to lessen their life as compared to this little boiler. An obsolete feature of this boiler is the vertical baffling, which was discarded in later designs for the horizontal baffling now the standard with Heine boilers of both the land and marine types. GEORGE H. GIBSON.



THE ORIGINAL HEINE BOILER, RECENTLY REMOVED

New York City.

Blank Charts for Recording Instruments

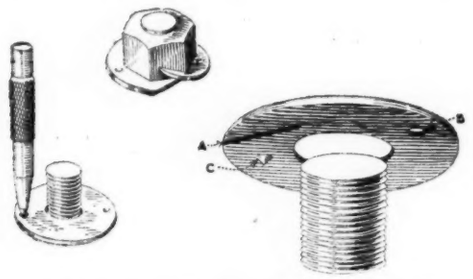
To decrease the cost of charts for recording instruments, so much in use in modern power stations, I would suggest that ordinary transparent paper in the shape of any given chart be used All that is necessary is to mark a starting point, zero time, on the periphery of the transparent chart and it is ready for use.

To find the characteristics of such a record, place the transparent chart over a regular chart, zero of the transparent coinciding with zero of chart. Only a few regular charts are required, and they will serve an indefinite length of time. HENRY WYGOD.

New York City.

A Successful Lock Washer

The description of a lock washer submitted by T. O. Vickers in the issue of Sept. 25, page 434, prompts me to describe one I have used several years, which I believe is just as effective, much more simple and easily made. In the illustration *A* is a slot in the washer, *B* is a small hole on the same radius as *C*, which is a small cone-shaped projection. When used on metal,



LOCK WASHER FOR WOOD OR IRON

place the washer in position and with a center punch make a depression through hole *B*, rotate the washer until projection *C* fits into the center-punch mark, screw down the nut and turn up the edge of the washer, at slot *A*, alongside of the nut. When used on wood, no punch mark is necessary. This washer can be cheaply made by a single operation of a punch press.

Glouster, Ohio. P. H. GRIGSBY.

The Unreliability of Fuses of Large Motor Circuits

The difficulty encountered in the use of large fuses arises from the fact that they do not act promptly when an overload occurs. This delay may endanger the winding of the motor and the feeders and also increase the fire risk in the building where the machine is situated. The writer has found them unreliable under normal conditions of operation; moreover, they are liable to blow for no apparent reason whatsoever. To cite a case in point, a 270-hp. 250-volt direct-current motor directly connected to a multistage centrifugal pump that was used for elevator service was protected by a pair of 1000-amp. standard inclosed fuses. Under the conditions of operation the maximum load on the machine was approximately 850 amp. Normally the fuses were decidedly worn to the hand when touched on the outer fiber casing, and after a few months' service one of the fuses gave out. The graphic meters on the station board showed no increase in load, consequently the cause of the blowout was attributed to deterioration of the fuse elements by continual heating. Some time after this another fuse gave out under similar conditions.

This motor is a compound machine and has an automatic regular in the shunt-field circuit. One day the resistance unit in this regulator developed an open circuit. The hand starter failing to throw off, the motor continued to operate as a series machine, thereby attaining a dangerous speed. The pressure on the elevator system increased to about 400 lb. per sq.in. and the current to approximately 1500 amp. before the fuses gave out. Fortunately no harm was done either to the motor or to the elevator system, but it is not difficult to imagine what might have occurred had a band given out on the armature owing to excessive speed or had a break occurred in the piping system throughout the building.

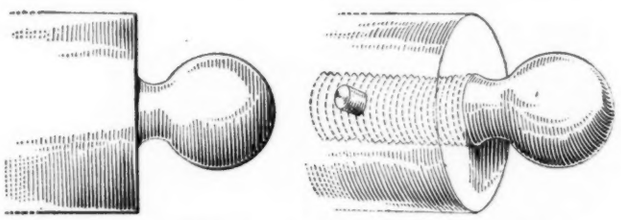
The necessity of installing a circuit-breaker in place of the fuses as a safeguard against further trouble was put up to the management of the concern, but the advice was not taken at the time. This is generally the way in human affairs; something has to happen first, then the remedy is quickly forthcoming.

The armature of the motor mentioned is of the bar-wound type, the conductors being held in place by wedges with bands at the ends only. The continuous heating evidently caused one of the wedges to become loose, and centrifugal force did the rest. One set of conductors rose out of the slot and began to rub on the pole pieces, and as the system has a grounded neutral, the current passed through the frame of the machine, and in doing so increased from 600 amp. to approximately 1400 amp. as was indicated on the chart of the graphic meter. The good old reliable fuses still held until the main switch on the board was pulled, with the result that several coils of the armature were destroyed, necessitating rewinding, and a hole was burnt in the commutator, owing to the open circuit. After this happened, the management decided to install a circuit-breaker. H. WILSON.

Toronto, Ont., Canada.

Repairing a Buckeye Governor

The shaft governor on one of our engines caused considerable annoyance by a persistent knock that was difficult to locate. It was found that the "dollhead" on the end of the weight arm was considerably worn. This is the ball part of the ball-and-socket joint at the junction of the weight arm and the rod through which the motion is transmitted to the eccentric. It was the first intention to turn out new weight arms, but since there was little wear anywhere except at the dollhead, a better suggestion was offered. We



WORN "DOLLHEAD" ON GOVERNOR REPLACED

drilled and tapped a $\frac{3}{4}$-in. hole 2 in. deep in the end of the weight arm, then turned a new dollhead with a shank threaded to fit into the tapped hole, and after screwing it in tight, a $\frac{1}{4}$-in. hole was drilled through and a neat fitting pin of soft steel wire was driven in and riveted over. Now, whenever this part needs renewal all that is necessary is to drive out the pin and unscrew the dollhead, without dismantling the governer, and fit the new one in place. This will save both time and temper as it is an awkward job to dismantle these governors. JOHN F. CURREN.

East Liverpool, Ohio.

Inquiries of General Interest

Purpose of Turbine Staging—What is the main reason for staging a steam turbine? F. N. C.

The main purpose is to obtain reduction of velocity and pressure of the steam gradually from stage to stage and thereby permit of a lower final velocity of the steam and a slower rotative speed of the turbine.

Object of Placing Cranks at Right Angles—In a cross-compound engine why are the cranks placed at an angle with each other? R. F. P.

The cranks are placed 90 deg. apart so that the maximum turning effect of one will coincide in time with the minimum effect of the other, and the result is to give greater uniformity of rotation during a revolution of the crankshaft.

Oil Grooves for Bearings—Why are oil grooves usually provided for only one-half of bearings; would it not be better if the whole bearing was provided with grooves to keep the lubricant in the bearing? J. L.

Oil grooves are for the purpose of distributing the supply of the lubricant between the bearing surfaces. If grooves are made in the half-box that receives pressure from the journal, the lubricant finding its way into the groove will stay there, or run off through the groove with little benefit to lubrication, or the channels become clogged and accumulation of solid matter is likely to set up cutting of the journal.

Ratio of a Series Transformer—Does the current ratio of a series or current transformer change with the line voltage? W. F. C.

The circuit voltage has no effect on the ratio of a current transformer. If the transformer is designed for 500 amperes on the primary to 5 on the secondary, this ratio holds true whether it is connected to a 110-volt circuit or a 11,000-volt circuit. The only difference in current transformers designed for high- and low-voltage circuits is in the insulation between primary and secondary windings and between primary and ground. This must be heavy enough to prevent puncture.

Scale of Indicator Spring—How would one determine the proper scale of spring that is to be used in an indicator? J. K.

Place a blank card on the indicator drum and, with a spring in the instrument, mark the height of the atmospheric line. Then remove the spring and ascertain how high in inches the pencil can travel on the drum. With most forms of indicators this will be between 2 and 2½ in. Subtract ½ in. from the ascertained height and, considering the remainder as the maximum height of diagram desired, divide the initial steam pressure by this height. The quotient will be the lowest scale of spring that is to be employed without risk of limiting the indication of the instrument to less than true maximum pressure. The next higher scale of spring that is available may be used, but in selecting a spring it should be borne in mind that the higher the scale of spring employed the smaller, and consequently less emphatic, the diagrams obtained.

Source of Napier's Formula—What is the source of the formula, $W = (P \times A) \div 70$ for the number of pounds of steam discharged per second from an aperture whose area in square inches is A; how is the divisor 70 obtained and why is P taken as absolute pressure instead of boiler pressure? H. C. S.

The formula was proposed in the middle of the last century by S. D. Napier, an English engineer, as a result of carefully conducted experiments, made by him in tests of the accuracy of abstruse mathematical formulas of flow that had previously been relied upon, but which he found to be in error. Napier's tests convinced him that the more intricate formulas modified to the simple formula, $W = (P \times A) \div 70$ would be nearly true in all cases where the initial pressure is 1⅞ times the pressure of the gaseous medium into which steam may be discharged, and the formula has been extensively verified and is accepted as substantially correct for such conditions. In the formula, P is taken in absolute pressure because the physical properties of steam depend upon the absolute pressure and not upon the gage pressure, which is accidental and depends on the variable pressure of the atmosphere.

Height of Raising Water by Siphonage—How high can water be raised in a siphon? W. E. K.

In a siphon that is operated by the pressure of the atmosphere, the water can be raised in the ascending leg of the siphon to such a height that the pressure due to the height of the water plus the losses of pressure at the entrance, loss of pressure due to friction and pressure in the crest of the siphon are less than the pressure of the atmosphere. When the descending leg is long enough to overcome the pressure of the atmosphere, a perfect vacuum cannot be maintained in the crest of the siphon because air or vapor liberated from the water at the reduced pressure in the crest eventually occupies so much space, or its presence causes so much pressure or frictional resistance to flow, that the siphon "breaks." The pressure of the atmosphere at sea level is equal to the pressure of a column of water 33.947 ft. high at 62 deg. F., and without frictional resistance or liberation of air or vapor from the water in the crest of a siphon, water could be raised to that height by siphonage. But as these interferences are always present, it is not practicable, under ordinary conditions, to raise water by siphonage to a greater height than 25 to 27 ft., and the length of time that the siphon can be maintained without breaking will depend upon the temperature and other conditions favorable to liberation of air and vapor.

Power Saved by Reduction of Belt Slippage—A motor running 650 r.p.m. with a 10-in. diameter pulley drives a machine with a 24-in. receiving pulley at 258 r.p.m. By eliminating the slip of belt, the machine makes 270 r.p.m. Can a reduction in current be effected if the motor pulley is reduced to 9½ in. diameter to obtain the original speed of the machine? E. D. C.

Belt slippage cannot be entirely eliminated. If 270 r.p.m. of the machine is realized, it is because the thickness of the belt increases the effective ratio of motor-pulley diameter to receiving-pulley diameter. Allowing for belt thickness of 0.3 in. and 10-in. diameter motor pulley, the speed of the machine without belt slippage would be $(10.3 \times 650) \div 24.3 = 275.5$ r.p.m., so that 270 r.p.m. would represent about 2 per cent. slippage. Practically the same percentage of slippage would be realized with the motor pulley of appropriate size for driving the machine at the original speed of 258 r.p.m. With 0.3 in. thickness of belt, the motor pulley should be $[(1.02 \times 258 \times 24.3) \div 650] - 0.3 = 9.52$, or practically 9½ in. diameter, as proposed.

The original speed of 258 r.p.m. with 10-in. diameter pulley on the motor was attended by $100 - (258 \times 100 \div 275.5) = 6.36$ per cent. slippage, and reduction of the slippage to 2 per cent. has resulted in saving of $6.36 - 2 = 4.36$ per cent. of the power. Resumption of the original speed of 258 r.p.m. with 9½-in. diameter pulley on the motor, and under the improved conditions, should result in about the same per cent. in saving of current required by the motor.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

American Boilermakers Ask Massachusetts To Amend Rules

THE Massachusetts Board of Boiler Rules gave a hearing at Boston Nov. 1 upon a petition of the American Boiler Manufacturers' Association for various changes in the Massachusetts Boiler Rules, conforming in detail to the A. S. M. E. Boiler Code. Representative manufacturers and insurance experts from New England opposed the suggested changes, chiefly on the ground that their superiority to the Massachusetts Rules not only had not been proved, but the existing regulations in the Bay State make for maximum safety. It was the consensus of opinion among the manufacturers of boilers in attendance that the proposed changes would mean a reduction from the high standards prescribed by the Massachusetts board. The board will probably consider the subject matter of the hearing at an executive session within the next two weeks, but in view of the small amount of technical data brought forward in support of the proposed changes, it seems unlikely that the amendments will go through at present. The board, of course, gave no intimation of its action, but took the whole matter under advisement. Chairman George A. Luck, chief of the boiler inspection department, presided.

H. N. Covell, secretary of the American Boiler Manufacturers' Association, presented the petition to the board. Mr. Covell pointed out the high reputation of the engineers who formulated the A. S. M. E. Boiler Code and urged that the proposed changes be admitted on the ground of the technical authority of the A. S. M. E. committee and in the interest of uniformity of action throughout the country. The speaker said he was authorized to present the petition at the twenty-ninth annual convention of the American Association at Pittsburgh, Penn., June 25 and 26, 1917. He said that he disclaimed expert knowledge of boiler manufacture, being a producer of hoisting engines, in the main. He paid a high tribute to the Massachusetts Rules, which he appreciated served as the foundation of the A. S. M. E. Code, and said that he based his advocacy of the changes upon the exhaustive work of the A. S. M. E. committee and its practically unanimous adoption by the American Boiler Manufacturers' Association.

Petitioned Changes in Massachusetts Rules (1917 Edition):

Shearing Strength of Rivets (p. 11, Par. 5): The maximum shearing strength of rivets per square inch of cross-sectional area is taken as follows in the Massachusetts Rules, the proposed figures being added:

	A.S.M.E.	Massachusetts
Iron rivets in double shear	76,000 lb.	70,000 lb.
Steel rivets in single shear	44,000 lb.	42,000 lb.
Steel rivets in double shear	88,000 lb.	78,000 lb.

Chemical Properties of Steel (p. 41, Par. 3): The A. S. M. E. Code provides that steel plates for any part of a boiler when exposed to the fire or products of combustion and under pressure shall be of firebox quality as designated in the Specifications for Boiler Plate Steel.

Massachusetts requires that there shall be *two* classes of boiler-plate; namely, openhearth firebox steel and extra-soft steel.

Stamping of Plates and Heads (p. 49, Par. 19): The A. S. M. E. Code requires that each shell plate shall be legibly stamped by the manufacturer with the melt or slab number, name of the manufacturer, grade and the minimum tensile strength of the stipulated range (as specified in Par. 28, A. S. M. E. Code) in *three* places, two of which shall be located at diagonal corners about 12 in. from the edge and one about the center of the plate, or at a point selected and designated by the purchaser so that the stamp shall be plainly visible when the boiler is completed. Massachusetts requires stamping each plate in at least *five* places; namely, at the four corners, at a distance of 12 in. from the edges, and at or near the center of the plate, with the name of the manufacturer, place where manufactured, brand and lowest tensile strength.

Shell Plates and Heads (p. 49, Par. 1): According to the A. S. M. E. Code, steel plates for any part of a boiler where firebox quality is not specified, when under pressure, shall be of firebox or flange quality as designated in the specifications for Boiler Plate Steel. The Massachusetts Rules require that shells, drums, butt straps, heads, combustion chambers, furnaces, or any plates that require staying or flanging, shall be of openhearth firebox or extra-soft steel.

Maximum Allowable Pitch of Screwed Stay-Bolts (p. 67, Sec. 4, Part 3): A large number of changes are apparent in the A. S. M. E. Code in the spacing of stay-bolts, compared with the Massachusetts Rules. The differences suggested are greater in the higher spacings and for the higher pressures:

THICKNESS OF PLATE IN INCHES

CHANGES IN MAXIMUM PITCH OF STAY-BOLTS, COMPARED, IN INCHES

M Signifies Massachusetts

Lb.	5/16 Code	5/16 M.	3/8 Code	3/8 M.	7/16 Code	7/16 M.	1/2 Code	1/2 M.	9/16 Code	9/16 M.	5/8 Code	5/8 M.	11/16 Code	11/16 M.
100	5 1/2	5 1/2	6 1/2	6 1/2	7 1/2	7	...	...	...	...	...	...	...	...
110	5	5 1/2	...	...	7	6 1/2	8 1/2	7 1/2	...	...	...	...	...	...
120	4 1/2	5 1/2	...	...	6 1/2	6 1/2	8	7 1/2	...	...	...	...	...	...
125	4 1/2	5	...	...	6 1/2	6 1/2	7 1/2	7	...	...	...	...	...	...
130	4 1/2	5	5 1/2	5 1/2	6 1/2	6 1/2	6 1/2	6 1/2	...	...	...	...	...	...
140	4 1/2	4 1/2	5 1/2	5 1/2	6 1/2	6	6 1/2	6 1/2	8 1/2	7 1/2	...	...	...	...
150	4 1/2	4 1/2	5 1/2	5 1/2	6	5 1/2	7 1/2	6 1/2	8	7 1/2	...	...	...	...
160	4 1/2	4 1/2	5	5 1/2	5 1/2	5 1/2	6 1/2	6 1/2	7 1/2	6 1/2	...	...	...	...
170	4	4 1/2	4 1/2	5	...	...	6 1/2	6 1/2	7 1/2	6 1/2	8 1/2	7 1/2	...	...
180	...	...	4 1/2	4 1/2	...	...	6 1/2	6	7 1/2	6 1/2	8 1/2	7 1/2	...	...
190	...	...	4 1/2	4 1/2	...	...	5 1/2	5 1/2	7 1/2	6 1/2	7 1/2	7	...	...
200	...	...	4 1/2	4 1/2	...	...	6 1/2	5 1/2	7	6 1/2	7 1/2	6 1/2	8 1/2	7
225	...	...	4 1/2	4 1/2	4 1/2	5	5 1/2	5 1/2	6 1/2	6	7 1/2	6 1/2	8	7
250	...	...	4	4 1/2	4 1/2	4 1/2	5 1/2	5 1/2	6 1/2	5 1/2	6 1/2	6 1/2	7 1/2	6 1/2
300	...	...	...	...	4 1/2	4 1/2	5	4 1/2	5 1/2	5 1/2	6 1/2	5 1/2	7	6 1/2

Stresses in Stays and Stay-Bolts (p. 78, Par. 35): The A. S. M. E. Code says that the maximum allowable stresses in stays and stay-bolts with unwelded stays less than 20 diameters long screwed through plates with ends riveted over, shall be 7500 lb. per square inch.

The Massachusetts Rules permit a range of maximum allowable stresses in stays and stay-bolts of from 6000 to 9000 lb. per sq.in., depending upon whether the diameter is under or over 1¼ in., upon the composition of the material (mild steel or wrought iron), and whether through or crowfoot stays are used.

Drilling of Stay-Bolts (p. 83, Par. "a"): According to the A. S. M. E. Rules, the ends of screwed stay-bolts shall be riveted or upset by equivalent process. The outside ends of such staybolts shall be drilled with a hole at least 1/8 in. diameter to a depth extending ½ in. beyond the inside of the plates, except on boilers having a grate area of less than 15 sq.ft., where drilling of the stay-bolt is optional.

In Massachusetts it is required that all stay-bolts, except those in vertical boilers having furnaces not over 44 in. diameter, shall be drilled from the outside end to a depth of not less than ½ in. inside the boiler plate and drilled to a diameter not smaller than 1/8 inch.

Location of Handholes (p. 90, Sec. 4, Part 3): A vertical fire-tube boiler, says the A. S. M. E. Code, except on the boiler of a steam fire engine, shall have not less than seven handholes located as follows: Three in the shell at or about the line of the crown-sheet; one in the shell at or about the line of the fusible plug when used; three in the shell at the lower part of the water-leg. A vertical boiler, submerged-tube type, shall have two or more handholes in the shell, in line with the upper tube sheet. The Massachusetts Rules require at least seven handholes, as above, but specify only two in the shell at or about the line of the crown-sheet; the latter rules call for one in the shell at or about the line of the fusible plug, this being optional in the A. S. M. E. Code, according to its interpretation, except in the case of a vertical fire-tube boiler having a manhole in the shell or head, through which the fusible plug is accessible. In Massachusetts the requirements include two handholes in the shell at the lower part of the water-leg and two at or about the water line of the boiler, except in the case of a vertical fire-tube boiler with a manhole. The A. S. M. E. Code does not require any handhole at or about water line.

Bottom Blowoff and Fittings (p. 96, Par. 18): The Massachusetts Rules requires two extra-heavy bottom blowoff

valves, or a valve and a cock, where the boiler pressure exceeds 100 lb. The A. S. M. E. Code, which the petitioners desire substituted, raises this pressure minimum to 125 lb. and adds that on a boiler having multiple blowoff pipes, a single master valve may be placed on the common blowoff pipe from the boiler, in which case only one valve on each individual blowoff is required.

Ogee Form of Construction (p. 98, Par. 1): In Massachusetts the ogee form of construction at the lower end of the furnace sheet is prohibited. The A. S. M. E. Code, however, permits the use of the ogee form of construction, the rule reading as follows: "Water-leg and door-frame rings of vertical fire-tube boilers 36 in. or over in diameter shall be of wrought iron or steel, or cast steel of class "B" grade, as designated in the specification for steel castings. The ogee or other flanged construction may be substituted in any case."

Discussion Upon Proposed Changes

In introducing the proposed changes enumerated, Mr. Covell said that Massachusetts had started the ball rolling by adopting the only comprehensive boiler law in the country. Uniformity is most desirable in the interests of safety, he stated. Sentiment is growing favorably toward a code of uniform application, and the State of New York has adopted the A. S. M. E. Code, which goes into effect there on Jan. 1, 1918.

C. F. Koopman, Jr., New England Iron Works Co., Boston, said that the petition to adopt the foregoing changes from the A. S. M. E. Code represents a lowering of the bars. He spoke of the large number of conferences which had been the means of bringing the Massachusetts Rules to their present status and could see no good reason for introducing other rules. He considered the Massachusetts Rules entirely suitable for universal application, speaking from a boilermaker's standpoint.

A. B. Carhart, Crosby Steam Gage and Valve Co., Boston, poured oil on the troubled waters by emphasizing the difficulties at present existing in regard to obtaining material representing the highest standards. Steel of a certain quality may be specified and obtained in the case of a few hundred sheets, but under war conditions there is not enough of the highest-grade material to meet all requirements. A manufacturer can attempt to meet unusual specifications from a small percentage of his customers, but he cannot cull out the best material and apply it to every class of order. The industry cannot stand a high percentage of unsalable discard. The A. S. M. E. Code does not prevent a manufacturer from working to a higher standard if he so desires. Something must be conceded to the needs of living and doing business at present, the speaker said. He would not advocate any unsafe practice for a moment, he announced, but intimated that if a large proportion of the engineering judgment of the country says that a given engineering standard is absolutely safe, not much is gained by insisting on exceeding a certain minimum. Peculiar specifications cannot be generally adopted or put into universal service without upsetting the entire industry.

Chairman Luck pointed out that under the A. S. M. E. Code boilers of below 36 in. diameter could be built with cast-iron door frames and rings. This is considered dangerous by the Massachusetts board. When riveting on a bull there is liability of cracking the door frame, if of cast iron. In response to a question, Mr. Luck said that the Massachusetts limitation of the maximum shearing strength of iron rivets to 70,000 lb. per sq.in. in double shear had always worked satisfactorily.

James C. Stewart, Stewart Boiler Works, Worcester, Mass., said that he does not favor carrying the rivet stresses as high as the A. S. M. E. Code allows. He thought that 80,000 lb. is high enough for steel rivets in double shear and 40,000 lb. for iron rivets in single shear. In general, a range of from 45,000 to 80,000 lb. appeared proper for steel rirvets under conditions of single to double shear.

F. N. Dillon, Dillon Boiler Works, Fitchburg, Mass., expressed his preference for the Massachusetts Code. J. A. Collins, secretary Mutual Boiler Inspection and Insurance Co., said that he could not see why boilermakers in other sections of the country could not conform to the admirable Massachusetts Rules, which he did not care to see modified in the mere name of safety. These rules, he stated, are easy to understand and easy to comply with. Mr. Covell said that the very flower of the country's engineering profession formulated the A. S. M. E. Code, the chairman of the committee being John A. Stevens, of Lowell, Mass. The American Boiler Manufacturers' Association represents 80 per cent. of the boiler horsepower rating produced in the country, and the A. S. M. E. Code was accepted with but one dissenting vote at its convention. All manufacturers of plates, rivets and tubes had had an opportunity to consider these rules. Mr. Carhart said that the A. S. M. E. Code committee had arranged for annual public meetings at which all states using the Code can present suggested changes for consideration, so that the Code need not be inflexible.

Mr. Stewart urged the retention of the Massachusetts rule (p. 49, Par. 1) permitting the use of extra-soft steel as well as firebox steel for openhearth boiler plate and rivets. This is needed now and will probably be needed more in the future. He said further that the A. S. M. E. Code favors one type of boiler to the detriment of makers of certain other types. The speaker wished to be shown wherein the A. S. M. E. Code is superior to the Massachusetts Code. Every issue of the society "Journal" contains proposed revision in the Code (six pages in June, 1917) and the council has recommended that some of these changes be incorporated. Mr. Stewart said that the A. S. M. E. Code allows courses over 12 ft. long if of butt-strap construction, but he could not consider such a length to be good practice. The society would not allow a heating boiler to be run at over 15 lb. per sq.in. This is a real hardship on many installations. The A. S. M. E. Code is long and so complicated as to require the services of a man detailed to its interpretation and giving all his time to the work. The Massachusetts Rules, he stated, are far simpler, and the United States Rules still shorter. The best plan would have been for the A. S. M. E. to have adopted the Massachusetts Rules and then by coöperative work necessary revisions could have been made. Mr. Dillon also favored the use of extra-soft steel in the construction of plates and rivets for steel shells and drums. J. F. Molloy, chief engineer, Mutual Boiler Insurance Co., prefers the use of soft steel in ogee flanges in the upright parts of the boiler.

Four-Corner Stamping Requires Extra Work

Mr. Carhart said that the steel maker considers the four-corner stamping requirement useless extra work. It involves turning and shifting the plate and increases the cost of production. In the A. S. M. E. Code a compromise was reached, under which stamping on two corners is required. Mr. Malloy defended the stamping of all four corners, and Mr. Luck said that the Massachusetts board insists that at least one stamp shall be placed on the plate after it is put in the boiler. Mr. Dillon said the Massachusetts law is a godsend to the manufacturer when piecing out. Regarding the pitch of stay-bolts he criticized the A. S. M. E. Code as carelessly framed in the higher pressures and plate thicknesses (see table of comparisons). He could not see the use of the third handhole specified opposite the crown-sheet in the A. S. M. E. Code, stating that either two, four or eight handholes would be more logical. Mr. Luck defended the use of handholes on the water line, saying that they are specially convenient in field work.

Mr. Stewart said it is advisable and economical to have two blowoff valves on every boiler even on a heating installation. The blowoff is a source of trouble from leakage and allowances have to be made for it in tests. Mr. Dillon opposed raising the pressure to 125 lb. in connection with this section (p. 96, Par. 18) stating that 75 lb. would be a preferable limit. Mr. Malloy also favored two blowoff valves as a preventive of full blowing down in case of obstruction under a valve seat.

Wrought iron or steel must be used in door frames and rings, Mr. Luck declared. Mr. Dillon said that the use of ogee construction would be a step backward. Closing, he pointed out that the New England Boiler Manufacturers' Association has twice voted unanimously against adopting the A. S. M. E. Code.

Comparative Total Production of Bituminous Coal in 1916 and 1917

September production of bituminous coal (including that made into coke), according to a report by the Geological Survey, is estimated at 43,573,652 net tons. Although the total output was smaller in September than in August, the rate of production increased from 1,737,685 net tons per working day in August to 1,793,154 tons in September. The total production from Jan. 1 to Sept. 30, 1917, was approximately 407,370,011 tons, an increase of 38,684,232 tons over the production for the corresponding nine months of 1916. The soft-coal mines of the country continue to

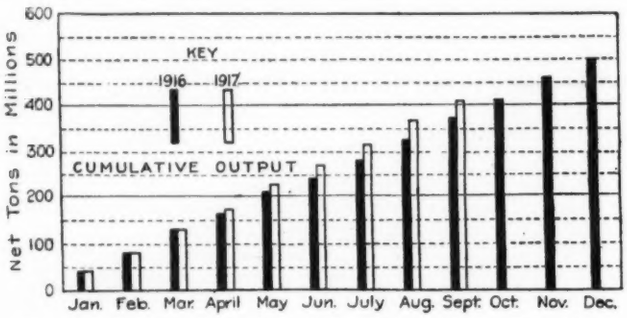


CHART SHOWING TOTAL AND COMPARATIVE OUTPUT OF COAL

produce in excess of last year's output, but the rate of increase is slowing down. During August the 1917 production gained four million tons over the corresponding 1916 production. During September the gain was only 1½ millions. Expressing the same idea in terms of per cent. by the end of August the 1917 production was 11.1 per cent. ahead of that for 1916; by the end of September it was only 10.5 ahead. It seems increasingly probable that the total production of the year 1917 will better the record of last year by not more than 10 per cent.

Causes and Remedies of Carbon Brush Troubles*

BY E. H. MARTINDALE

The causes and remedies for sparking at brushes are:

1. Brushes off electrical neutral—Shift to neutral by trial or set on neutral by means of voltmeter.

2. Brushes spanning too many bars—Trim down faces of brushes to obtain proper thickness or, if holders are clamp type, use thinner brushes.

3. Brush studs not parallel with the commutator bars—Bend the brush studs or grind or shim under the bolts which fasten the studs to the yoke until stud is parallel with segments.

4. Incorrect brush spacing—Check the spacing by counting the number of bars between studs or by placing a strip of paper around the commutator with divisions marked off equal to the number of studs, and correct spacing by rotating the brush studs or the brush holders on the studs.

5. Brushes tight in brush holders—Clean the holders with gasoline, and if brushes are still tight, sandpaper them down or file out the holders carefully.

6. Brush pressure too low—Pressure should be 1.75 to 1.5 lb. per sq.in. cross-section for stationary motors and generators, 2.5 to 4 lb. for elevator and mill motors, 3 to 5 lb. for crane motors, 4 to 7 lb. for railway motors.

7. Too low contact drop of brush—Consult a brush manufacturer.

8. Insufficient abrasive action of brushes—Use a commutator stone or more abrasive brushes.

9. High mica—Use abrasive brushes, a commutator stone or undercut the mica.

10. Chattering—See general heading "Noise" for remedies.

11. Poor adjustment of interpoles—Consult the manufacturer of the machine.

12. Overloads—Undercut the mica, use low-friction brushes and check up all causes for short-circuit currents (see general heading "Heating") to reduce temperatures as much as possible.

13. Open-circuit in armature coil—Rewind that part of the armature or make temporary repairs at commutator.

14. Loose connection at commutator—Scrape and resolder all defective connections.

15. Worn bearings—Shim or renew the bearings.

16. Unequal air gaps—Shim the short poles or grind off the faces of the long poles, or if from worn bearings, see paragraph 15.

17. Short-circuit currents between brush studs caused by unbalanced armature winding—Consult the manufacturer of the machine.

18. Eccentric commutator on high-speed machine—Turn or grind down to true surface.

19. Poor belt lacing—Relace or, still better, use an endless belt.

20. Pounding of reciprocating engine driving the machine.

21. Unstable foundation.

22. Cross-currents between generators operated in parallel driven by reciprocating engines, due to variation in angular speed of engines—Use heavier flywheel.

The causes and remedies of flat spots on the commutator are:

1. Any form of sparking—See foregoing sections for definite causes and remedies.

2. High bars—Tighten the commutator bolts and turn or grind down the commutator.

3. Low bars—Tighten the commutator bolts and turn or grind the commutator.

4. Eccentric commutator on high-speed machine causing the brush to jump from the commutator at the high spots—Turn or grind the commutator.

5. Surges of load current due to short-circuit on the line or an instantaneous high peak load.

6. Mechanically unbalanced armature—Place on balancing ways and add weight at lightest point.

7. Difference in hardness of commutator bars—Undercut the mica and use nonabrasive brushes.

8. Difference in hardness of mica—Undercut the mica and use nonabrasive brushes.

The causes and remedies for blackening of the commutator are:

1. Sparking—See general heading "Sparking" for causes and remedies.

2. Too much lubricant in brushes or use on commutator—Clean commutator with gasoline.

The causes and remedies of a direct-current motor or generator heating are:

1. Severe sparking—See general heading "Sparking."

2. Short-circuit currents.

2a. Brushes off neutral.

2b. Faulty brush spacing.

2c. Too thick brushes.

2d. Unequal air gaps.

2e. Crooked brush studs.

2f. Too low contact drop of brushes.

2g. Unbalanced armature winding.

For remedies see same causes under general heading, "Sparking."

3. Too high or too low brush pressure—For recommendations see paragraph 6 under "Sparking."

4. High-friction brushes—Undercut mica and use low friction brushes.

5. Commutator too small—Consult the manufacturer of the machine.

6. Too high a ratio of brush area to commutator surface—Use fewer brushes of higher carrying capacity and lower friction.

7. Overloads—See paragraph 12 under general heading "Sparking."

8. Chattering of brushes—See general heading "Noise."

The cause and remedies of pitting or honey-combing of brush faces are:

*Abstract from a paper, "Manufacture, Selection and Use of Carbon Brushes," presented at the eleventh annual convention of the Association of Iron and Steel Electrical Engineers, held in Philadelphia, Penn., Oct. 10 to 14, 1917.

1. Short-circuit currents—See paragraph 2 under the heading, "Heating."

2. Too low brush pressure—See paragraph 6 under general heading "Sparking."

3. Brushes of insufficient carrying capacity—Consult a brush manufacturer.

The causes and remedies for the brushes picking up copper are:

1. Heavy short-circuit currents—See paragraph 2 under general heading "Heating."

2. Sand under the brush faces—Wipe brush face carefully after sandpapering either brushes or commutator.

3. Commutator not thoroughly cleaned after turning—Finish the surface with a commutator stone.

4. Collection of copper dust by lubricant in abrasive brushes—Undercut the mica and use nonabrasive brushes.

5. Electrolytic action—Change the grade of brush; better consult a brush manufacturer.

The causes and remedies for brushes chattering are:

1. High-friction brushes—Change the grade of brushes or pressure.

2. Rough commutator—Use a commutator stone.

3. Dirty commutator—Clean with gasoline.

4. High mica—Use a commutator stone or undercut mica.

5. Wide slots between bars with thin brushes—Fill the slots with commutator cement.

6. High bars—Tighten the commutator bolts and turn or grind the commutator.

7. Flat spots—Use commutator stone unless the flat spots are too large for stoning, in which case turn or grind the commutator.

8. Brush operating at the wrong bevel, frequently found where brushes are operating in a stubbing position with angles of less than 20 degrees—Change the grade of brush or angle of operation. Better consult a brush manufacturer or the manufacturer of the machine.

The loosening of brush shunts is caused by:

1. Poor workmanship in attaching shunts.

2. Insufficient carrying capacity—Consult a brush manufacturer.

3. Heating—See general heading "Heating."

4. Vibration—See general heading "Noise."

5. Combination of heating and vibration.

6. Loose terminal screws causing unequal distribution of load.

7. Unequal brush pressure causing unequal distribution of load—See that all brush pressures are uniform and conform to recommendations given in paragraph 6 under general heading "Sparking."

8. Heavy short-circuit currents between different brushes—See subdivisions 2b, 2d, 2e and 2g under general heading "Heating."

Engineering Affairs

The National Association of Practical Refrigerating Engineers will hold its annual convention at Vicksburg, Miss. Dec. 6-8.

The New England Water Works Association will hold its next meeting at the Boston City Club, cor. Somerset and Ashburton Place, Boston, Mass., Nov. 14.

The Society of Naval Architects and Marine Engineers will hold its twenty-fifth general meeting at the Engineering Societies Building, 29 West 39th St., New York City, Nov. 15-16.

The Atlantic City Association of the N. A. S. E. will hold its annual banquet Jan. 29. Further particulars may be had from Arthur Truman, chief engineer, The Shelbourne Hotel, Atlantic City, N. J.

The Eastern Ice Association will hold its eleventh annual meeting Nov. 13, 14, 15 and 16, Hotel Chelsea, Atlantic City, N. J. The program includes six papers on the steam and electrical services in ice plants.

The New York Section of the American Society of Mechanical Engineers will hold a meeting at the Engineering Societies Building, 29 West 39th St., New York, on Nov. 13. Maxwell M. Upson will present a paper on "Concrete Piling."

The Chicago Section of the American Society of Mechanical Engineers will hold a meeting on Nov. 16. Major Peter J. Junkersfeld will address the section on "Cantonment Construction." The council of the A. S. M. E. will meet in Chicago on the same date.

The Fifth Annual Pennsylvania Welfare and Efficiency Conference will be held in the hall of the House of Representatives at Harrisburg on Nov. 21 and 22. The arrangements are being made by the Department of Labor and Industry, which, on request, will furnish programs and other information desired.

The New Jersey Board of Boiler Rules met Nov. 5 at Newark, N. J., for consideration of a code for regulation of existing boiler installations and means of securing adequate inspection. Information before the board revealed the fact that there are about 7500 power boilers in use in the state, of which number about 2250 are neither regularly inspected nor insured.

The American Association for the Advancement of Science and many national scientific societies affiliated with it will hold its seventieth meeting in Pittsburgh, Penn., from Dec. 28, 1917, to Jan. 2, 1918, under the auspices of the University of Pittsburgh, the Carnegie Institute, the Carnegie Technical Schools and other scientific and educational institutions of the city.

The Following National Officers of the National Association of Stationary Engineers were entertained by Jersey City No. 1 Association, Friday evening, Nov. 2 at Arcanum Hall, Jersey City. President, John Wickert, Milwaukee; secretary, F. W. Raven, Chicago; treasurer, Samuel B. Forse, Pittsburgh; chairman board of trustees, William J. Reynolds, Hoboken; trustee, Joseph O'Connell, Chicago; trustee, Joseph Carney, New York. Billy Murray, Bobby Jones and other talent for Jenkins Bros. and Jack Armour, of "Power," all under direction of Frank Martin, entertained.

The Combined Associations of the N. A. S. E. of Manhattan, Bronx and Queens held their sixteenth annual entertainment and ball at Terrace Garden, New York City, on Saturday evening, Nov. 3. Several of the national officers were present. There were large delegations from Brooklyn and New Jersey, and many prominent persons in the engineering field were in attendance. During the evening Mayor Mitchel delivered a short address to the assemblage. His speech was enthusiastically received. An enjoyable program of six specially selected numbers from B. F. Keith's theaters preceded a long dancing program. The officers of the combination include David Larkin, chairman; Andrew Anderson, vice chairman; William Logan, treasurer; Arthur Jaynes, secretary.

The Connecticut Section of the American Society of Mechanical Engineers will hold its fall meeting at New Haven on Nov. 14. The afternoon session will be held at Lampson Lyceum, Yale University. Prof. L. P. Breckenridge will speak on "The Problem of Coal Conservation," followed by discussion by other speakers on "Fuel Saving Suggestions"; C. D. Terry, of the National Tube Co., will give an illustrated talk entitled "From Ore to Finished National Pipe." Dinner will be served at the Yale Dining Club at 6 p.m. The evening session will be held at Mason Laboratory. An address will be made by Dr. Ira N. Hollis, president of the A. S. M. E. The following papers will be read: "Fuel Conservation by the Bureau of Mines," by O. P. Hood, mechanical engineer of the Bureau of Mines, Washington; "Conservation Work of the Coal Administrator," by P. B. Noyes, representative of the Coal Administrator on Fuel Conservation. These will be followed by suggestions and general discussion on the subject of fuel conservation.

Personals

David J. Armour has recently joined the selling force of the Peerless Rubber Manufacturing Co.

C. W. Johnson, general superintendent of the East Pittsburgh works of the Westinghouse Electric and Manufacturing Co., was elected vice president of the American Institute of Metals at its recent annual meeting.

A. C. Townsend, for the last twelve years with the Green Fuel Economizer Co. in various capacities, has resigned to become associated with H. R. Geiger, sales agent for power-plant equipment and the Moore Steam Turbine Corporation.

Thomas Easton Allan, of South Park, Lincoln, England, has been appointed to a seat on the Board of Robey & Co., Ltd., Lincoln. For several years he has been connected with the management and is intimately acquainted with the working of all departments.

John R. Monaghan, who has been connected with the engineering department of the Public Service Commission, New York, for the last ten years, has resigned to become associated with the Rapid Transit Subway Construction Co., New York, as engineer of subway construction.

Dr. Milton W. Franklin, formerly engineer of the ozonator department of the General Electric Co., has resigned to go with E. F. Houghton & Co. as consulting engineer. He has been appointed a member of the board of directors and chairman of the sales committee and assumes charge of plants and equipment and manufacturing processes.

Miscellaneous News

Electric Street Lighting in Boston has been ordered curtailed by James J. Storrow, New England fuel administrator, in order to save coal. Not only will night advertising signs be eliminated, but the city officials will cut off the current from many powerful street lamps; theater display signs will be dark after 9 o'clock at night.

The Two Reinforced-Concrete Tunnels for the Louisville Gas and Electric Co.'s Waterside Station, designed by the engineering department of H. M. Byllesby & Co., have been completed and the Waterside Station is now receiving all its water for condensing and other purposes by means of these huge water ducts.

Electric Plant Unit Taken by Government—A 1500-kw. turbo-generator that was being built by the General Electric Co. for the city electric plant, of Richmond, Va., has been commandeered by the Emergency Fleet Corporation, and as soon as it is completed it will be used at a government plant at Bristol, Penn. The city has spent about $15,000 in purchasing the generator and in erecting an addition to its local electric plant, for which an appropriation of $25,000 was made some months ago.

Boiler Manufacturers' War Service Committee—Conforming to resolution adopted at the meeting of manufacturers with the National Chamber of Commerce requesting all lines of business to appoint a war-service committee to act as "point of contact" between said industry and the United States Government during the period of the war, the American Boiler Manufacturers' Association has appointed its committee as follows: George W. Bach, manager, Union Iron Works, Erie, Penn.; G. S. Barnum, president, Bigelow Co., New Haven, Conn.; W. C. Connelly, chairman, president, The D. Connelly Boiler Co., Cleveland, Ohio. Anyone having business pertaining to boilers should address the chairman at once.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Nov. 8, 1917	One Year Ago	Nov. 8, 1917	One Year Ago
Buckwheat ..	$4.98—5.20	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.40—4.65	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	.....	.....	.....	.....
Barley	3.90—4.15	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Prices per gross ton for Boston delivery are as follows:

	F.o.b. Mines*		Alongside Boston†	
	Nov. 8, 1917	One Year Ago	Nov. 8, 1917	One Year Ago
Clearfields....	.....	$3.00	.....	$4.25—5.00
Cambrias and Somersets...	.....	3.10—3.85	.....	4.60—5.40

Note—Bituminous not on market.
Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago; on cars Boston price is $8.50—8.75.
*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Nov. 8, 1917	One Year Ago	Nov. 8, 1917	One Year Ago
Buckwheat ..	$3.95—4.65	$2.75	$5.10—5.30	$4.00—5.00
Rice	3.40—3.60	2.20	3.80—4.10	2.50—3.00
Barley	2.90—3.15	1.95	3.00—3.30	2.00—2.50

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate).....	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Nov. 8, 1917	One Year Ago	Nov. 8, 1917	One Year Ago
Buckwheat ...	$2.90	$2.00	$3.80	$2.90
Rice	2.40	1.25	3.40	2.15
Boiler	2.20	1.10	3.30	2.00
Barley	1.90	1.00	2.15	1.90

Pittsburgh—Price of steam coal per net ton f.o.b. mine, Pittsburgh district:

	Nov. 8, 1917	One Year Ago
Slack	$3.00—3.25	$4.00—4.50
Mine-run	3.00—3.25	5.00
¾-in.	3.50—3.75	3.35—3.85

Add 20c. per ton for freight charge to Pittsburgh.

Chicago—Current prices per net ton f.o.b. mines are as follows:

	Counties Williamson and Franklin	Harrisburg Saline and	Smokeless West Virginia	field Spring-	Counties Clinton and Sullivan
Steam lump ..	$2.65	$2.65	$2.70	$2.65	$2.65
Lump	2.65	2.65	2.70	2.65	2.65
Egg	2.65	2.65	2.70	2.65	2.65
Nut	2.65	2.65	2.70	2.65	2.65
No. 1 nut....	2.65	2.65	2.70	2.65	2.65
No. 2 nut....	2.65	2.65	2.70	2.65	2.65
No. 3 nut....	2.65	2.65	2.70	2.65	2.65
No. 1 washed.	2.65	2.65	2.70	2.65	2.65
No. 2 washed.	2.65	2.65	2.70	2.65	2.65
Mine run	2.40	2.40	2.40	2.40	2.40
Screenings	2.15	2.15	2.20	2.15	2.15

Hocking lump, $2.60; split lump, $2.40.

Northern Illinois thin vein—Prepared sizes, $2.65; mine-run, $2.40; screenings, $2.15.

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Nov. 8, 1917	One Year Ago	Nov. 8, 1917	One Year Ago	Nov. 8, 1917	One Year Ago
6-in lump ..	$2.65	$2.75	$2.65*	$2.25	$2.65	$2.00
2-in lump ..	2.65	2.75	2.65*	2.25	2.65	2.00
Steam egg...	2.65	2.75	2.65*	2.25	2.65*	2.25
Mine-run ...	2.40	1.75	2.40*	1.85	2.40	1.65
No. 1 nut...	2.65	2.75	2.65*	2.25	2.65	2.00
2-in. screen..	2.15	1.40	2.15*	1.35	2.15	1.25
No. 5 washed	2.15	1.30	2.15*	1.30	2.15	1.25

*Strike.
Williamson-Franklin rate St. Louis, 72½c.; other rates, 57½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona....	2.15	2.40	1.90
Black Creek, Cahaba ...	2.40	2.65	2.15

Government figures.

[1]Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Ala., Dothan—The Columbia Power Co. plans to build a large power house for which the Bate site on the Columbia River has been secured.

Calif., Brawley—City has authorized G. R. Wade, City Engr., to draw preliminary plans for the construction of an electric-lighting plant.

Calif., Kittridge—(Bagby P. O.)—The San Joaquin Light and Power Co., Fresno, plans to extend its transmission line from here to Coulterville; also lines to several mining plants. G. O. Newman, Los Angeles, Ch. Engr.

Calif., Portola—The electric-lighting plant of the Grizzly Electric Co., which was recently destroyed by fire with a loss of about $7000, will soon be rebuilt.

Iowa, Glenwood—City plans to install an electric-lighting plant.

Kan., Cuba—City will vote on $10,000 bond issue for the installation of an electric-lighting system here.

Md., Baltimore—The Consolidated Gas, Electric Light and Power Co., Lexington and Liberty Sts., is having plants prepared for the erection of a new power distributing station on Custom House Ave. E. D. Edmonton, Gen. Supt.

Minn., Atwater—The Light and Power Co. of St. Cloud has been granted a franchise for the erection of an electric-lighting system.

Miss., Pascagoula—The International Shipbuilding Co. plans to erect an electric-lighting plant here.

Mo., Pleasant Hill—L. K. Green and Son, Harrisonville, plans to build a central power plant here.

Mont., Moore—The Montana Power Co., Butte, is having plans prepared for a large hydro-electric development at the foot of Mystic Falls. F. M. Kerr, Butte, Gen. Supt.

Mont., Plevna—City has plans under consideration for the installation of an electric-lighting and power plant. State Bros. of Baker, are interested.

Nev., Ely—F. B. Ench, 2535 10th Ave., Oakland, Calif., has submitted plans to the Commissioner of Corporation for hydro-electric development provided power to the copper mines here. An expenditure of $1,200,000 is planned.

N. M., Ft. Stanton—The Custodian of the U. S. Sanitorium, Ft. Stanton, will receive bids until Nov. 26 for furnishing electric generating equipment, f.o.b. cars, Capitan, N. M.

N. Y., Central Islip—State Hospital Commission, Albany, will receive bids until Nov. 14 for the erection of a power house. E. S. Elwood, Secy.

N. C., Fremont—The Town Commissioners plan to issue $20,000 in bonds for the installation of an electric-lighting plant and the improvement of streets.

Ont., Hamilton—H. W. Petrie, Kittridge, is in the market for 5 and 10 hp. hydro motors.

Ont., Thornton—City passed a resolution to install a hydro-electric power plant here.

Penn., Weatherly—The Weatherly Foundry and Machine Co. plans to erect a new power plant here.

Tenn., Lebanon—City voted favorably on a bond issue of $25,000 for the installation of an electric-lighting plant and water-works system.

Tex., Cookville—B. B. Stevens plans to build an electric-lighting and power plant here.

Tex., Jefferson—The Jefferson Ice and Light Co. plans to install a new electric motor and other equipment in its light and power plant here.

Tex., Navasota—The Intermountain Light and Power Co., 412 Mining Exch. Bldg., Colorado Springs, Colo., plans to rebuild its distributing plant. W. Corson, Supt.

D. C., Washington—Official)—The Bureau of Supplies and Accounts, Navy Dept., Wash., soon receives bids for furnishing under Schedule 1542 at various navy yards, 26,000 lb. asbestos for valve stems packing; 255,000 lb. fiber sheet compressed asbestos packing; 8500 sq.yd. asbestos metallic cloth sheet packing; 5000 lb. asbestos metallic cloth tape packing; 7000 sq.yd. sheet fiber for joints packing; 147,000 lb. flax packing; 150,000 lb. sheet rubber grade 1, cloth insertion packing; 26,000 lb. hard sheet rubber grade 2, cloth insertion packing; 80,500 lb. sheet rubber, with wire insertion, packing; 24,000 lb. sheet for high-pressure joints packing; 23,500 lb. spiral gland packing; 180,000 lb. high-pressure spiral rod packing; 37,000 lb. square Tucks without rubber core packing.

Wis., Marinette—The Brown-Mitchelson Co. plans to build an addition to its electric-lighting plant here.

Wis., Watertown—The Washington Cutlery Co. plans to build a new heating and power plant here in connection with its new factory now being built. Estimated cost, $10,000.

Wis., Waupun—The Rock River Valley Hemp Mills plans to build a 30 x 30-ft. addition to its power house here; also install 150 hp. engines.